

Mater of Technology in Engineering Analysis and Design
Department of Applied Mechanics

The overall credits structure

Category	PC	PE	OC	Total
Credits	33	12	6	51

Programme Core (PC)				Programme Electives (PE)			
				Product Design			
APL775	Design Methods	3-0-0	3	APL776	Product Design and Feasibility Study (Stream Core)	2-0-4	4
APL753	Properties and Selection of Engineering Materials	3-0-0	3	APL710	Computer Aided Design	3-0-2	4
APL703	Engineering Mathematic and Computation	3-0-2	4	APL871	Product Reliability	3-0-0	3
APL701	Continuum Mechanics	3-0-0	3	APL771	Design Optimization and Decision Theory	3-0-0	3
APL700	Experimental Methods	1-0-2	2	APL 774	Modeling & Analysis of Mechanical Systems	3-0-0	3
APD 811	Major Project Part 1	0-0-12	6	APL 767	Engineering Failure Analysis and Prevention	3-0-0	3
APD 812	Major Project Part 1	0-0-24	12				

M.Tech. in Design Engineering

Sem.	Courses (number, abbreviated title, L-T, credits)							Lecture courses	Contact h/week				Credits
									L	T	P	Total	
I	APL775 Design Methods (3-0-0)3	APL753 Prop. & selection of Engg. Mat. (3-0-0)3	APL703 Engg. Math. & Computation (3-0-2)4	APL701 Continuum Mechanics (3-0-0)3	APL700 Experimental Methods (1-0-2)2			5	13	0	4	17	15
Summer	APD811												
II	PE-1	PE-2	PE-3	OE-1					12	0	0	12	12
III	OE2	APD811	PE-4						6	0	12	18	12
IV	APD812								0	0	24	24	12

Total : 51

Mater of Technology in Engineering Mechanics
Department of Applied Mechanics

The overall credits structure

Category	PC	PE	OC	Total
Credits	33	12	6	51

Programme Core (PC)				Programme Electives (PE)			
				Engineering Mechanics			
APL775	Design Methods	3-0-0	3	APL734	Advanced Dynamics	3-0-0	3
APL753	Properties and Selection of Engineering Materials	3-0-0	3	APL705	Finite Element Method	3-0-2	4
APL703	Engineering Mathematic and Computation	3-0-2	4	APL835	Mechanics of Composite Materials	3-0-0	3
APL701	Continuum Mechanics	3-0-0	3	APL831	Theory of Plates and Shells	3-0-0	3
APL700	Experimental Methods	1-0-2	2	APL796	Advanced Solid Mechanics	3-0-0	3
APD 811	Major Project Part 1	0-0-12	6	APL765	Fracture Mechanics	3-0-0	3
APD 812	Major Project Part 1	0-0-24	12	APL711	Advanced Fluid Mechanics	3-0-0	3
				APL720	Computational Fluid Dynamics	3-0-2	4
				APL713	Turbulence and its Modeling	3-0-0	3
				APL715	Physics of Turbulent Flows	3-0-0	3
				APL716	Fluid Transportation Systems	3-0-0	3

M.Tech. in Engineering Mechanics

Sem.	Courses (number, abbreviated title, L-T, credits)							Lecture courses	Contact h/week				Credits
									L	T	P	Total	
I	APL775 Design Methods (3-0-0)3	APL753 Prop. & selection of Engg. Mat. (3-0-0)3	APL703 Engg. Math. & Computation (3-0-2)4	APL701 Continuum Mechanics (3-0-0)3	APL700 Experimental Methods (1-0-2)2			5	13	0	4	17	15
Summer	APD811												
II	PE-1	PE-2	PE-3	OE-1					12	0	0	12	12
III	OE2	APD811	PE-4						6	0	12	18	12
IV	APD812								0	0	24	24	12

Total : 51

COURSE TEMPLATE

Experimental Methods (APL700)

1.	Department /Centre /School proposing the course	Applied Mechanics		
2.	Course Title	Experimental Methods		
3.	L-T-P structure	1-0-2		
4.	Credits	2	Non-graded Units	-
5.	Course number	APL 700		
6.	Course Status (Course Category for Program)			
	Institute Core for all UG programs		(No)	
	Programme Linked Core for:		-	
	Departmental Core for:		M.Tech Program in Engineering Analysis and Design.	
	Departmental Elective for:		-	
	Minor Area / Interdisciplinary Specialization Core for:		-	
	Minor Area / Interdisciplinary Specialization Elective for:		-	
	Programme Core for:		-	
	Programme Elective for:		-	
	Open category Elective for all other programs (No if Institute Core)		(Yes)	
7.	Pre-requisite(s)	-		
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	N/A	
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	N/A	
8.2	Supersedes any existing course			N/A
9.	Not allowed for	N/A		

10.	Frequency of offering (check one box)	☐ Either semester
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11.	Faculty who will teach the course: VT, SNS, SVV, MRC
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12.	Will the course require any visiting faculty? No
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13.	Course objectives (about 50 words. "On successful completion of this course, a student should be able to..."): The main objective of the course is to introduce students to the latest techniques in the field of Design, Materials, Solid and Fluid Mechanics.
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14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): Basic principles of experimental analysis, Types of experiments, Planning of Experiments, Experiment design factors and protocols, Calibration, Standards, Measurement techniques, Methods for measuring flow, Sensors and Transducers, Errors analysis, Uncertainty analysis and propagation of uncertainty, Statistical analysis of the results, Probability distribution, Gaussian error distribution, multivariable regression, correlations, curve fits and Fourier analysis.
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1.	Introduction.	1
2.	Basic principles of experimental analysis, Types of experiments, Planning of Experiments, Experiment design factors and protocols.	3
3.	Sensors and Transducers.	3
3.	Errors analysis, Uncertainty analysis and propagation of uncertainty, Statistical analysis of the results, Probability distribution, Gaussian error distribution,	3
4.	Multivariable regression, correlations, curve fits and Fourier analysis.	4
Total Lecture hours(14 times 'L')		14hrs

16. Brief description of tutorial activities: N/A

Module no.	Description	No. of hours

Total Tutorial hours(14 times 'T')	
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17. Brief description of Practical / Practice activities:

Module no.	Description	No. of hours
1.	Basic Electrical Measurements – Analog meters, digital meters, oscilloscope, signal conditioning, time and frequency measurements, Transducers (resistive, capacitive, piezoelectric), photovoltaic cells.	2
2.	Data Acquisition and Processing – General DAQ system, Data Transmission, Analog to Digital & Digital to Analog conversion, Data storage and display.	4
3.	Displacement and Area measurement – Gage blocks, calipers, Transducers, Planimeter.	2
4.	Pressure Measurement – Dead weight tester, Bourdon tube, diaphragm and bellow gages, Other pressure transducers.	2
5.	Flow Measurements – Flow obstruction method, Nozzles, Hot wire anemometry, Hot film anemometry, laser Doppler anemometer, Instrumentation in two-phase flows.	4
6.	Temperature Measurements – Different types of thermometers (gas, mechanical, electrical, radiation), thermocouples, transient response of thermal systems, temperature measurements in high speed flow.	2
7.	Motion and Vibration measurement – Sound measurements, Accelerometers, Seismic Instruments.	4
8.	Force, Torque and Strain Measurement – Piezo elements for force measurement, resistance strain gauges, rosettes, uniaxial elongation using UTM, etc.	4
9.	Wave measurement – Wave propagation in bars and other structures.	2
10.	Air Pollution and Sampling – Pollution Measurement, Standards, Air sampling technique, opacity measurements, Odor measurement.	2
Total Practical / Practice hours(14 times 'P')		28 hrs

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.	Design and fabrication of an experimental Setup.
2.	Analysis of the results.

(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.

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|---|
| 1. Experimental Method for Engineers by J. P. Holman, (7 th Edition), McGraw-Hill Companies. |
| 2. Instrumentation, Measurement and Analysis by B. C. Nakra and K.K. Chaudhry, (3 rd Edition 2010)Tata McGraw Hill |

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

20.1	Software	-
20.2	Hardware	-
20.3	Teaching aids (videos, etc.)	-
20.4	Laboratory	-
20.5	Equipment	-
20.6	Classroom infrastructure	White board, projection system.
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	50%
21.2	Open-ended problems	10%
21.3	Project-type activity	10%
21.4	Open-ended laboratory work	Nil
21.5	Others (please specify)	Nil

Date:

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

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

COURSE TEMPLATE

1.	Department/Centre proposing the course	APPLIED MECHANICS
2.	Course Title	Continuum Mechanics
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	APL701
6.	Status (category for program)	Core for PG

7.	Pre-requisites	None
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8.	Status vis-à-vis other courses (give course number/title)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supercedes any existing course	None

9.	Not allowed for (indicate program names)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course: Prof. Puneet Mahajan, Prof. S V Veeravalli, Prof. Sanjeev Sanghi, Prof. Santosh Kapuria, Prof. B P Patel, Dr Ajeet Kumar	
12.	Will the course require any visiting faculty?	None

13.	Course objective (about 50 words): The primary objective of the course is to introduce basic contents of solid and fluid mechanics to first year PG students in common framework of “Continuum Mechanics” so that they pursue advanced topics in the respective areas at a later stage.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Concept of continuum, kinematics of deformation, concept of stress and strain tensor – their transformation and decomposition, finite strain tensor and its linearization with examples, rate of deformation tensor – velocity gradient and spin tensor, derivation of conservation laws – mass continuity, linear and angular momentum conservation, derivation of linear equations of elasticity and Navier Stokes equations in both cartesian and polar co-ordinates, principle of minimum potential energy, virtual work theorem, uniqueness and reciprocal theorem, constitutive laws for linearly elastic solids and newtonian viscous fluids, incompressible case, applications in solid and fluid
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	mechanics problems.
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Math preliminaries	1
2	Particle kinematics in both lagrangian and eulerian framework	1
3	Concept of Cauchy-stress tensor, transformation, principal stresses, normal and shear stresses, principle stresses with examples	4
4	Concept of strain tensor – lagrangian and eulerian strain tensor, infinitesimal strain tensor, normal and shear strains in both finite and infinitesimal cases with examples, compatibility conditions, rate of deformation gradient – velocity gradient and spin tensor	7
5	Derivation of conservation laws – mass continuity, linear and angular momentum balance, derivation of linearized equations of elasticity and Navier stokes equations in both cartesian and polar co-ordinates	6
6	Constitutive laws for linearly elastic solids and newtonian viscous fluids	2
7	Principle of minimum potential energy, virtual work theorem, uniqueness and reciprocal theorem	3
8	Solid mechanics application – plane stress/plane strain problems, bending and twisting of non-circular shafts, stress based formulation (airy stress function), displacement potential function	9
9	Fluid mechanics application – Integral flow analysis, Reynolds transport theorem, Bernouli equations and exact solutions, Boundary layer concept and equations	9
		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		

7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. A.J.M. Spencer, Continuum Mechanics, Dover publishers, 2004
2. J.N. Reddy, An Introduction to Continuum Mechanics, Cambridge Univ. Press, 2007

B. References**19. Resources required for the course (itemized & student access requirements, if any)**

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	White Board, Projection
19.7	Site visits	

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

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	Engineering Mathematics and Computation
3.	L-T-P structure	3-0-2
4.	Credits	4
5.	Course number	APL703
6.	Status (<i>category for program</i>)	Core

7.	Pre-requisites (course no./title)	none
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	none
8.2	Overlap with any UG/PG course of other Dept./Centre	none
8.3	Supercedes any existing course	no

9.	Not allowed for (indicate program names)	none
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course: All faculty
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12.	Will the course require any visiting faculty?	no
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13.	Course objective (<i>about 50 words</i>): The objective of the course is to introduce students to a variety of topics in engineering mathematics that would useful to them for their courses in design and analysis.
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Tensors, Vector Calculus; Linear Algebra – Solution of Linear Systems, Eigenvalue Problems; Variational calculus; Fourier Series and transform, Analytical and Numerical Solution methods of ODEs, Partial Differential Equations – properties and solution techniques, Probability and Statistics
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Vectors, Tensors, Index Notation, Transformation of Coordinates	2
2	Review of Vector Calculus, Div, Grad, Curl, Curvature, Integral Theorems	2
3	Linear Systems of Equations : Gauss Elimination, Linear	3

	Independence, Vector Spaces, Inner Product, Linear Transformations	
4	Eigen Values, Eigenvectors, Bases, Diagonalization, Quadratic Forms	2
5	Methods for Nonlinear systems of equations – Newton Raphson	1
6	Variational Calculus	5
7	Fourier Series and Fourier Transform	5
8	Ordinary Differential Equations : Analytical Solutions for 1 st and 2 nd order linear ODEs. Qualitative analysis of nonlinear ODEs, Runge-Kutta methods for IVPs, Finite Difference Methods	8
9	Partial Differential Equations : Classification, Basic Solutions of Heat, Wave and Laplace Equations, Introduction to Finite difference methods for PDEs	6
10	Probability and Statistics	8
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

There is no additional slot for tutorials. However, assignments (including programming) will be given periodically.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Introduction to Programming/MATLAB	4
2	Solution of Linear Systems	4
3	Solution of Nonlinear Systems	4
4	Fast Fourier Transform	2
5	ODEs – RK methods	4
6	ODEs – Finite Difference	4
7	PDEs – Laplace, Heat and Wave	6
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

Since this course involves various topics, we will have a series of reference books according to the topic instead of a single textbook

1. G. Strang, Differential Equations and Linear Algebra, Wellesley-Cambridge, 2014
2. G. Strang, Introduction to Applied Mathematics, Wellesley-Cambridge, 1986
3. G. Strang, Computational Science and Engineering, Wellesley-Cambridge, 2007
4. I.M. Gelfand and V.Fomin, Calculus of Variations, Dover, 2000
5. M.T. Heath, Scientific Computing, McGraw-Hill, 2002

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

19.1	Software	MATLAB
19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	none
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	FINITE ELEMENT METHOD
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	APL705
6.	Status (<i>category for program</i>)	PC for M.Tech. (Engg. Mech) & PE for M.Tech. (Design Engg.), OE for others

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	no

9.	Not allowed for (<i>indicate program names</i>)	none
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course P Mahajan, S Kapuria, B P Patel, M K Singha, A Kumar, S Roy	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): Finite element method is an important tool for the approximate analysis of different engineering problems, for example, solid mechanics, fluid mechanics, heat transfer etc. The purpose of this course is to introduce this approximate technique for solution of boundary and initial value problems through domain discretization.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Strong and weak forms of governing differential equations, and their equivalence, Weighted residual and variational approaches. Ritz method. Discretization of weak form and boundary conditions. Convergence. Bar and beam elements. Truss and frame problems, Isoparametric formulation. Plane strain, plane stress and axis-symmetric problems, 3D elasticity problems, one and two dimensional heat transfer. Formulation of dynamics problems. Laboratory work on solid mechanics and heat transfer problems.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Finite Element Method	1
2	Strong and Weak formulation of governing differential equations and their equivalence, Ritz Method	3
3	Discretization of weak form and associated matrix problem	4
4	Tension /compression in bars, Truss problems	6
5	One dimensional heat transfer and fluid flow problems	4
6	Bending of beams and frame problems	6
7	Isoparametric element and Numerical Integration	4
8	Plane stress and Plane strain problems, Axi-symmetric Problems	6
9	Three dimensional problems in solid mechanics	2
10	Two-dimensional Heat transfer problems	2
11	Formulation of dynamic problems, Time Integration techniques	2
12	Concluding Remarks	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Introduction to programming	2
2	Development of Bar elements	2
3	Plane truss problems	2
4	Beam problems	4
5	Frame problems	2
6	Plane stress problems	4
7	Plane strain and axi-symmetric problems	4
8	Heat transfer problems	4
9	Mass matrix, fundamental frequency and mode shape for beams	4
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. T. R. Chandrupatla and A D Belegundu, Introduction to Finite Elements in Engineering, PHI Learning Private Limited, 2011.
2. J. N. Reddy, An Introduction to the Finite Element Method, Tata McGraw-Hill, 2005
3. O. C. Zienkiewicz, R. L. Taylor and J. Z. Zhu, Finite Element Method, Its basis and Fundamentals, Sixth Edition, Elsevier, 2005. Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics, The Finite Volume Method, 2e, Prentice Hall, UK, 2007.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	MATLAB
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19.2	Hardware	
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	Computational laboratory with at least 20 computer terminals
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	none
20.2	Open-ended problems	none
20.3	Project-type activity	none
20.4	Open-ended laboratory work	none
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	COMPUTER AIDED DESIGN
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	APL710
6.	Status (<i>category for program</i>)	Programme Core for AMD, Departmental Elective for others
7.	Pre-requisites (<i>course no./title</i>)	none
8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	CSL781,EEL754,MAL754 Computer graphics courses(< 10%) MEL414 (< 15%)
8.3	Supercedes any existing course	no
9.	Not allowed for (<i>indicate program names</i>)	none
10.	Frequency of offering	☒ Every sem ☐ 1 st sem ☐ 2 nd sem ☐ Either sem
11.	Faculty who will teach the course Dr. Shriram Hegde, Dr. Ajeet Kumar	
12.	Will the course require any visiting faculty?	no
13.	Course objective (<i>about 50 words</i>): This course is designed for developing understanding of basic principles of computer aided design starting from computer graphics to geometrical modeling. The course aims to give insight on practical aspects of curves, surface and solid modeling needed in design applications.	
14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Principles of computer aided design, Computer graphics fundamentals, 2D and 3D Transformations and projections, Plane Curves, Space Curves, Synthetic curves, Analytical and parametric surfaces, Synthetic surfaces, Solid Modeling basics, Solid modeling techniques and schemes, Half-spaces, Boundary Representation (B-rep), Constructive Solid Geometry(CSG), Sweep Modeling, Analytical Solid Modeling, Visual Realism, hidden lines and surface	

	algorithms, clipping, ray tracing Modeling exercises using solid modelers: Part modeling, editing model geometries, study of constraints, creating instances and features, curves and surface modeling, Assembling parts, Drafting Programing Exercises: Application of 2D and 3D Transformations and Projections, Examples of Curves and surfaces, clipping, ray tracing
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introductory Ito CAD	1
2	Basic concepts of computer graphics	3
3	Two-dimensional transformations	4
4	Three-dimensional transformations	4
5	Projective transformations	4
6	Parallel and Perspective projections	4
7	Plane curves and parametric representation	4
8	Space curves	3
9	Synthetic curves, cubic, Bezier, B-spline curves	4
10	Surface representation, bi-parametric, sweep, revolution, synthetic types, bicubic, Bezier, B-spline surfaces	4
11	Solid modeling, schemes, construction methods, validation methods and data structures	5
12	Visual realism, hidden line/surface algorithms	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

There is no additional slot for tutorials. However, as per the need, few lab hours may be converted into full-fledged tutorial class.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Introduction to solid modeler	4
2	Parts modeling exercises	4
3	Constraints and geometry editing	4
4	Curves modeling	2
5	Surface modeling	3
6	IMass Property Calculations	3
7	Generating drawing views from models	2
8	Parametric Modeling	2
9	Assembly exercises	2
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

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

1. Ibrahim Zeid, CAD/CAM Theory and Practice, TMH,
2. David F. Rogers and J. Alan Adams, Mathematical Elements for Computer Graphics, TMH, 2002
3. David F. Rogers, Procedural Elements for Computer Graphics, TMH, 2002.
4. Michael E. Mortenson, Geometric Transformations for 3D Modeling, Second Edition, Industrial Press, New York 2007
5. Michael E. Mortenson, Geometric Modeling, Third Edition, Industrial Press, New York 2006

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	MATLAB, Mathematica, SolidWorks, Catia, UGS NX
19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	Computing and Design Optimization Laboratory
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	Design of algorithms and software tools (10%)
20.2	Open-ended problems	Theoretical developments related to modeling and algorithms (5%)
20.3	Project-type activity	Graphics programming for geometrical modeling
20.4	Open-ended laboratory work	Imaginative and thought provoking modeling exercises (5%)
20.5	Others (please specify)	Term papers and class assignments

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	Advanced Fluid Mechanics
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	APL711
6.	Status (<i>category for program</i>)	Stream elective for Engineering Analysis and Design, Engineering mechanics stream

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	APL360
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supercedes any existing course	

9.	Not allowed for (<i>indicate program names</i>)	UG students who have taken APL360
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course: Prof. S. V. Veeravalli, Prof. S. N. Singh, Prof. S. Sanghi, Prof. A. Dewan, Dr. S. Balaji, Dr. M. Cholemari, Dr. S. Suman	
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): To reinforce the fundamentals of Fluid Mechanics. In this course the students will be exposed to a range of advanced topics in incompressible flows. Compressible flows will also be introduced.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Mathematical Preliminaries, Kinematics, Navier Stokes equations and some standard solutions, Low Reynolds number flows and Lubrication, Vorticity dynamics, Introduction to boundary layers, Hydrodynamic stability, 1-D compressible flows	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1.	Introduction and Mathematical preliminaries	2
2.	Kinematics	3
3.	Non dimensionalization of the Navier-Stokes equations, Thin layer	4

	approximation	
4.	Low Reynolds number flows and Lubrication	5
5.	Vorticity Dynamics	6
6.	Boundary Layer equations, Momentum Integral equation	6
7.	Introduction to Hydrodynamic Stability, Rayleigh equation and Orr-Sommerfield equations	6
8.	Internal flows	5
9.	One dimensional compressible flows, Normal shocks	5
		42

16. Brief description of tutorial activities

Not Applicable

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. Pantan R. L., <i>Incompressible Flow</i>, 3rd Ed., Wiley India, (2006) 2. Kundu P. K., Cohen I. M. and Dowling D. R., <i>Fluid Mechancs</i>, 5th Ed., Elsevier India Pvt. Ltd. (2012) 3. Tritton D. J., <i>Physical Fluid Dynamics</i>, 2nd Ed., Clarendon Press, (1988) 4. White, F. M., <i>Fluid Mechanics</i>, 7th Ed., McGraw Hill Education (India), (2011)
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19. Resources required for the course (itemized & student access requirements, if any)

19.1	Software	NA
19.2	Hardware	NA
19.3	Teaching aides (videos, etc.)	Fluid Mechanics Videos (available on you tube)
19.4	Laboratory	NA

19.5	Equipment	NA
19.6	Classroom infrastructure	LCD projector, Tablet/White Board
19.7	Site visits	NA

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

20.1	Design-type problems	NA
20.2	Open-ended problems	20%
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	Turbulence and its Modelling
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	APL 713
6.	Status (<i>category for program</i>)	Elective for M.Tech. in Engineering Analysis and Design, Department of Applied Mechanics

7.	Pre-requisites (<i>course no./title</i>)	None
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supercedes any existing course	

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course: Prof. Sanjeev Sanghi, Dr. Sawan Suman, Prof. Srinivas Veeravalli, Dr. Murali Cholemari, Prof. Anupam Dewan	
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): To help students develop fundamental understanding of the multi-scale processes of turbulence, its statistical and filtered description, turbulence closure problems and turbulence modeling.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Nature of turbulence, Governing equations, Fourier, Lagrangian and Eulerian description of turbulence, Statistical description of turbulence, Kolmogorov's hypotheses, turbulence processes, turbulence closure modelling	
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15. Lecture Outline (*with topics and number of lectures*)

Module no.	Topic	No. of hours
1	Brief overview of flow instability and transition	2
2	Governing equations of turbulence & Eulerian, Fourier and Lagrangian description of turbulence	6

3	Statistical description of turbulence and closure problem, Evolution equation of Reynolds stress tensor	6
4	Turbulence spectra, Kolmogorov's hypotheses, scaling laws	5
5	Turbulence models and their hierarchy– zero equation, one-, two- and 6-equation closure	6
6	Canonical turbulent flows (boundary layer, wakes, jets, mixing layer) and applicability of various turbulence models	6
7	Turbulence processes (rapid distortion theory to study production process, decaying homogenous turbulence to study dissipation and pressure-strain correlation processes)	7
8	Filtering approach to turbulence	4
		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities NA

Module no.	Experiment description	No. of hours
1		
2		
3		
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7		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. Pope, S. B., Turbulent Flows, Cambridge University Press, 2000.
2. Wilcox, D.C., Turbulence Modeling for CFD, D.C.W. Industries, 3rd Edition, 2006.
3. Tennekes, H. and Lumley, J.L. , A First Course in Turbulence, The MIT Press, 1972.
4. White, F.M., Viscous Fluid Flow, TATA McGraw Hill, 2011

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

19.1	Software	NA
19.2	Hardware	NA
19.3	Teaching aides (videos, etc.)	NA
19.4	Laboratory	NA
19.5	Equipment	NA
19.6	Classroom infrastructure	Classroom equipped with projector, screen,

		blackboard, seating capacity =50
19.7	Site visits	NA

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

20.1	Design-type problems	NA
20.2	Open-ended problems	NA
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Applied Mechanics	
2.	Course Title (<i>< 45 characters</i>)	The Physics of Turbulent Flows	
3.	L-T-P structure	3-0-0	
4.	Credits	3	
5.	Course number	APL715	
6.	Status (<i>category for program</i>)	Stream Elective for Engineering mechanics stream	

7.	Pre-requisites (<i>course no./title</i>)	APL711	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre		
8.2	Overlap with any UG/PG course of other Dept./Centre		
8.3	Supercedes any existing course	AML812	

9.	Not allowed for (<i>indicate program names</i>)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course : Srinivas Veeravalli, Sanjeev Sanghi, Anupam Dewan, Balaji Srinivasan, Sawan Suman, Murali Cholemari		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To develop the theory of turbulent flows with an emphasis on imparting a physical understanding of the processes involved.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction, nature of turbulence, methods of analysis, scales of turbulent flows. Reynolds decomposition and the closure problem, estimates of the Reynolds stress, comparison with the kinetic theory of gases. Dynamics of turbulence, balance of kinetic energy, vorticity dynamics, scalar fluctuations. Free shear flows: jets, wakes and mixing layers. Wall bounded flows: channel and pipe flows, boundary layers. Kolmogorov hypotheses; probability density function, characteristic function and moments; structure and correlation functions; energy spectra, intermittency. Turbulent transport and dissipation.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction, nature of turbulence, methods of analysis, scales of turbulent flows.	3
2	Reynolds decomposition and the closure problem, estimates of the Reynolds stress, comparison with the kinetic theory of gases.	3
3	Dynamics of turbulence, balance of kinetic energy, vorticity dynamics, scalar fluctuations.	6
4	Free shear flows: jets, wakes and mixing layers.	6
5	Wall bounded flows: channel and pipe flows, boundary layers.	8
6	Kolmogorov hypotheses; probability density function, characteristic function and moments; structure and correlation functions; energy spectra; intermittency.	10
7	Turbulent transport and dissipation	6

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities NA

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
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7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. Tennekes H. and Lumley J. L., A first Course in Turbulence, MIT press, 1972.
2. Pope S. B., Turbulent flows, Cambridge University Press, 2000.
3. Townsend A. A., The structure of Turbulent Shear Flow, Cambridge University Press, 1976.
4. Batchelor G. K., Theory of Homogeneous Turbulence, Cambridge University Press, 1953.
Davidson P. A., Turbulence, Cambridge University Press, 2004.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	NA
19.2	Hardware	NA
19.3	Teaching aides (videos, etc.)	Fluid Mechanics videos
19.4	Laboratory	NA
19.5	Equipment	NA
19.6	Classroom infrastructure	Board, LCD projector
19.7	Site visits	No

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

20.1	Design-type problems	
20.2	Open-ended problems	30%
20.3	Project-type activity	10%
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics
2.	Course Title (< 45 characters)	Fluid Transportation Systems
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	APL716
6.	Status (category for program)	Elective for M.Tech. in Engineering Analysis and Design, Department of Applied Mechanics

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (give course number/title)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supercedes any existing course	None

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course: Prof. S.N.Singh	
12.	Will the course require any visiting faculty?	No

13.	Course objective (about 50 words): To help students develop fundamental understanding of the transportation of material and solids through pipelines. It shall also cover all aspects of an efficient transportation systems viz. Design, Operation, Protection, Facilities etc.	
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14.	Course contents (about 100 words) (Include laboratory/design activities): Mechanism of transportation of materials by fluid flow, rheology and classification of complex mixtures, fundamentals of two-phase flow, Phase separation and settling behavior, Slurry Pipeline Transportation, Design methods, terminal facilities, pipe protection, pneumatic conveying, pneumocapsule and hydrocapsule pipelines, metrology associated with pipelines.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Mechanism of transportation of materials by fluid flow	4
2	Rheology and classification of complex mixtures	6
3	Fundamentals of two-phase flow	6
4	Phase separation and settling behavior	5
5	Slurry Pipeline Transportation	5
6	Design methods, terminal facilities, pipe protection	5
7	Pneumocapsule and hydrocapsule pipelines	6
8	Metrology associated with pipelines.	5
Total Lectures		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities NA

Module no.	Experiment description	No. of hours
1		
2		
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7		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. G.W. Govier & K. Aziz, The Flow of Complex Mixtures in Pipes, Van Nostrand Reinhold Company, 1972
2. E.J. Wasp, J.P. Kenny & R. L. Gandhi, Solid-Liquid Flow Slurry Pipeline Transportation, Trans Tech Publications, Series on Bulk material Handling Vol. 1 (1975/77) No. 4.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	NA
19.2	Hardware	NA

19.3	Teaching aides (videos, etc.)	NA
19.4	Laboratory	NA
19.5	Equipment	NA
19.6	Classroom infrastructure	Classroom equipped with projector, screen, blackboard, seating capacity =50
19.7	Site visits	NA

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

20.1	Design-type problems	NA
20.2	Open-ended problems	NA
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Applied Mechanics	
2.	Course Title (<i>< 45 characters</i>)	COMPUTATIONAL FLUID DYNAMICS	
3.	L-T-P structure	3-0-2	
4.	Credits	4	
5.	Course number	APL720	
6.	Status (<i>category for program</i>)	Departmental Elective	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	no	

9.	Not allowed for (indicate program names)	none	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Sanjeev Sanghi, Balaji Srinivasan, Anupam Dewan, Sawan Suman		
12.	Will the course require any visiting faculty?	no	

13.	Course objective (<i>about 50 words</i>): CFD is an important tool in engineering analysis and design of fluid systems. In this course, equations describing the numerical solutions to fluid flow will be developed. Time accurate and steady-state methods, for 2-D and 3-D, laminar and turbulent flows will be considered. Students are expected to learn to formulate and solve fluid flow problems that are encountered in real situations.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Review of governing equations for fluid flow, finite volume method and its application to steady 1-D, 2-D and 3-D convection-diffusion problems, extension of FVM to unsteady 1-D, 2-D and 3-D convection diffusion problems, pressure-velocity coupling, staggered and colocated grids, solution of discretized equations, physical description of turbulence, Reynolds-Averaged Navier-Stokes equations, closure problem; RANS based turbulence models; DNS and LES.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introductory Lecture	2
2	Conservation Laws of Fluid Motion and Boundary Conditions	4
3	Finite Volume Method for Diffusion Problems	2
4	Finite Volume Method for Convection-Diffusion Problems	4
5	Solution Algorithms for Pressure-Velocity Coupling in Steady Flows	4
6	Solutions of Discretised Equations	3
7	Finite Volume Method for Unsteady Flows	4
8	Introduction to Finite Difference Method	2
9	Fluid Turbulence and its Modelling: RANS Equations and Closure Problem, RANS equations based turbulence models	8
10	DNS and LES	4
11	CFD Analysis of Practical Problems	3
12	Concluding Remarks: Challenges Ahead	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Overview of programming in MATLAB	2
2	One dimensional Steady State problems: Diffusion, Convection-Diffusion	4
3	Two Dimensional Steady Problems	2
4	Unsteady Problems -- Heat Equation (1D and 2D)	4
5	2D Incompressible Navier-Stokes : Lid Driven Cavity Flow using SIMPLE	6
6	Commercial Software based solutions of laminar problems -- Lid Driven Cavity, Backward Facing Step, Flow Past Cylinder	4
7	Commercial Software based solutions of turbulent flows -- Backward Facing Step, Flow in Pipe, Flow past cylinder, Flow past airfoil	6
8		
9		
10		
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

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

1. Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics, The Finite Volume Method, 2e, Prentice Hall, UK, 2007.
2. Patankar, S.V., Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, USA, 2011.
3. White, F.M., Fluid Mechanics, 5e, McGraw-Hill, Inc, USA, 2003.
4. Dewan, A., Tackling Turbulent Flows in Engineering, Springer, Germany, 2011.
5. Wilcox, D.C., Turbulence Modelling for CFD, 3e, DCW Industries, USA, 2006.

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	ANSYS Fluent
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	Computational laboratory with at least 20 computer terminals
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	One course project will be assigned towards the end of the semester
20.4	Open-ended laboratory work	
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	APPLIED MECHANICS
2.	Course Title (<i>< 45 characters</i>)	ADVANCED DYNAMICS
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	APL734
6.	Status (<i>category for program</i>)	PE

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supercedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course: SA,SK,MKS,BPP,SP,VT,PM,AK	
12.	Will the course require any visiting faculty?	

13.	Course objective (<i>about 50 words</i>): The objective of the course is to introduce basic and advanced topics of vibrations and illustrate significant applications to determine dynamic response of components/structures.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Single Degrees of Freedom systems, Multi-degree of freedom systems, Response spectrum, Time integration schemes, Lagrange's equations, Principle of virtual work, continuous system	
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1.	Free vibration of single-degree-of –freedom (SDOF) systems, undamped and damped systems	3
2.	Forced vibration of single-degree-of –freedom (SDOF) systems, undamped and damped systems, rotating unbalanced mass, whirling of rotating shafts	3
3.	Harmonic motion of the support, energy dissipation, response to periodic excitation, impulse response, Response to general loading, Duhamel integral	5
4.	Energy principles, Lagrange’s equation, Work and energy, principle of virtual work, D’Alembert’s principle, Lagrange’s equations of motion	5
65.	Two-degree-of-freedom systems, orthogonality of modes, beat phenomenon	5
6.	Multi-degree-of-freedom systems, eigenvalue problem, modal analysis	5
7.	Time integration schemes	3
8.	Continuous system, free vibration, bending vibration of rods, bars, beams and plates	6
9.	Rayleigh’s energy method, Rayleigh-Ritz method. Symmetric and antisymmetric modes	5
10.	Kinematics of moving frames & respective applications	2
		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
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COURSE TOTAL (14 times ‘P’)		

18. Suggested texts and reference materials

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

B. References

1. Clough RJ and Penzien J, Dynamics of Structures, McGraw-Hill International, Second Edition, 1993.
2. Mario Paz, Structural Dynamics Theory and Computation, CBS Publishers, Second Edition, New Delhi, 2004.
3. Leonard Meirovitch, Elements of Vibration Analysis, McGraw-Hill International, Second Edition, 1986.
4. Wu, JS Analytical and Numerical methods for Vibration analysis, Wiley, 2013
5. Principles of Vibration, B.H. Tongue, Oxford University Press, Second Edition, Newyork, 2002.
6. Rao SS, Mechanical Vibrations, Pearson, Fifth Edition.

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

19.1	Software	MATLAB, Mathematica
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	White Board, Projection
19.7	Site visits	

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

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	MODERN ENGINEERING MATERIALS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	APL750
6.	Status (<i>category for program</i>)	Departmental elective

7.	Pre-requisites (course no./title)	none
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supercedes any existing course	no

9.	Not allowed for (indicate program names)	none
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. Rajesh Prasad, Dr. Jayant Jain, Dr. Anamika Prasad	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): The first half of the course provides understanding of structure and properties of wide range of materials (e.g. metals, polymers, glass, composites etc.) The second half provides an in depth understanding on specific materials in various engineering applications.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Elastic moduli, coefficient of thermal expansion: how properties are related with the bonding between the atoms, packing of atoms in solids, crystal structure, Plastic deformation of materials: yield strength, tensile strength, ductility and toughness of materials, perfect crystal, role of dislocations, strengthening methods, continuum aspects of plastic flow, Fatigue, fracture and creep of materials, ductile and brittle failure, micromechanism of failure, fatigue failure, Creep deformation and failure, mechanism of creep, Oxidation and corrosion of materials, carbon steels, alloy steels, TRIP steel, Dual phase steel, Bainitic steel, Martensitic steel, aluminum alloys, titanium alloys, carbon	
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	nanotubes, structure and properties of novel engineering materials: Composite materials, hybrid materials, metal foams, nanocrystalline materials, smart materials, case studies of materials applications in automotive, aerospace, power generation sectors etc.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Elastic moduli, coefficient of thermal expansion: how properties are related with the bonding between the atoms	3
2	Packing of atoms in solids, crystal structure	4
3	Plastic deformation of materials: yield strength, tensile strength, ductility and toughness of materials, perfect crystal, role of dislocations, strengthening methods, continuum aspects of plastic flow	4
4	Fatigue, fracture and creep of materials, ductile and brittle failure, micromechanism of failure, fatigue failure, Creep deformation and failure, mechanism of creep	6
5	Oxidation and corrosion of materials	2
6	Carbon steels, alloy steels, TRIP steel, Dual phase steel, Bainitic steel, Martensitic steel	6
7	Aluminum alloys, titanium alloys, carbon nanotubes	6
8	Structure and properties of novel engineering materials: Composite materials, hybrid materials, metal foams, nanocrystalline materials, smart materials,	6
9	case studies of materials applications in automotive, aerospace, power generation sectors etc.	5
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

There is no additional slot for tutorials

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
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7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

- | |
|---|
| 1. M. F. Ashby, D. R. H. Jones, Engineering Materials I and II, 4th Ed., Butterworth Heinemann, 2013. |
|---|

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	none
19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	none
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	None
20.2	Open-ended problems	None
20.3	Project-type activity	One course project will be assigned towards the end of the semester
20.4	Open-ended laboratory work	None
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	PROPERTIES AND SELECTION OF ENGINEERING MATERIALS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	APL753
6.	Status (<i>category for program</i>)	Departmental elective

7.	Pre-requisites (course no./title)	none
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supercedes any existing course	no

9.	Not allowed for (indicate program names)	none
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. Rajesh Prasad, Dr. Jayant Jain, Dr. Anamika Prasad	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): After completion of this course the students will be familiar with a broad range of material properties and will be able to select materials and processes for various engineering applications. Students should be able to use Materials selection software.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Historical evolution of engineering materials, evolution of materials in products, Engineering materials and their properties: families of engineering materials, materials information for design, materials properties, Materials property chart: exploring materials properties, materials property charts e.g. the modulus-density chart, the strength-density chart, the fracture toughness-modulus chart, thermal conductivity-electrical resistivity chart, Materials selection-the basics: the selection strategy, materials indices, the selection procedure, Multiple constraints and conflicting objectives: selection with multiple constraints, conflicting objectives, Selection of materials and shape: shape factors, limits to	
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	shape efficiency, exploring the materials shape combinations, materials indices that include shape, architected materials, Processes and process selection: classification of processes: shaping, joining and finishing, processing for properties, process selection, ranking process cost, Designing hybrid materials: holes in materials property space, composites, sandwich structures, cellular structures, segmented structures, case studies.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Historical evolution of engineering materials, evolution of materials in products	1
2	Engineering materials and their properties: families of engineering materials, materials information for design, materials properties,	5
3	Materials property chart: exploring materials properties, materials property charts e.g. the modulus-density chart, the strength-density chart, the fracture toughness-modulus chart, thermal conductivity-electrical resistivity chart,	3
4	Materials selection-the basics: the selection strategy, materials indices, the selection procedure,	5
5	Multiple constraints and conflicting objectives: selection with multiple constraints, conflicting objectives,	5
6	Selection of materials and shape: shape factors, limits to shape efficiency, exploring the materials shape combinations, materials indices that include shape, architected materials,	5
7	Processes and process selection: classification of processes: shaping, joining and finishing, processing for properties, process selection, ranking process cost,	5
8	Designing hybrid materials: holes in materials property space, composites, sandwich structures, cellular structures, segmented structures, case studies.	5
9	Selecting Materials for eco-design and sustainability	3
10	Case study, Materials selection software	5
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

There is no additional slot for tutorials.
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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

- | |
|---|
| 1. M. F. Ashby, Materials Selection in Mechanical Design, 4 th Ed., Butterworth Heinemann, |
|---|

2011

2. M. F. Ashby, D. R. H. Jones, Engineering Materials I and II, 4th Ed., Butterworth Heinemann, 2013
3. M. F. Ashby, H. Shercliff and D. Becon, Materials Engineering, Science, Processing and Design, 3rd Ed., Butterworth Heinemann, 2013.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	CES Edu Pack, Cambridge Materials Selector
19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	none
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	None
20.2	Open-ended problems	None
20.3	Project-type activity	One course project will be assigned towards the end of the semester
20.4	Open-ended laboratory work	None
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics	
2.	Course Title (<i>< 45 characters</i>)	PHASE TRANSFORMATIONS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	APL759	
6.	Status (<i>category for program</i>)	Departmental elective	

7.	Pre-requisites (course no./title)	none	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	None	
8.2	Overlap with any UG/PG course of other Dept./Centre	None	
8.3	Supercedes any existing course	no	

9.	Not allowed for (indicate program names)	none	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Prof. Rajesh Prasad, Dr. Jayant Jain		
12.	Will the course require any visiting faculty?	no	

13.	Course objective (<i>about 50 words</i>): The objective of the course is to provide an understanding of advanced phase transformations in materials. This includes range of different industrial treatments given to various materials such as casting, quenching of steels, precipitation hardening, recrystallization etc. during the processing of materials. The understanding of this is very important to control the microstructure and hence the properties of materials.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Classification of phase transformations in materials, thermodynamics and kinetics of phase transformations, nucleation and growth concepts. Spinoidal decomposition, reconstructive and displacive transformations, specific transformations such as casting, martensitic, bainitic, polymorphic, recrystallization, grain growth, precipitation hadening, particle coarseining, etc., crystallographic aspects of phase transformations, case studies in phase transformations.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Classification of phase transformations, Thermodynamics and kinetics of transformations	6
2	Solidification: nucleation and growth concepts, application to casting	5
3	Spinoidal decomposition	2
4	Reconstructive and displacive transformations	7
5	Martensitic and Bainitic transformations	5
6	Recrystallization and grain growth	5
7	Precipitation hardening, particle coarsening	5
8	Crystallographic aspects of phase transformations	5
9	Case studies in phase transformations	2
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

There is no additional slot for tutorials.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. D. Porter, K. E. Easterling and M. Sherif, 3rd Ed., CRC Press, Taylor and Francis Group, 2012.
2. M. Hillert, Phase Equilibria, Phase Diagrams and Phase Transformations Their Thermodynamic Basis, 2nd Edition, 2007.
3. V. Raghvan, 2nd Ed., Solid state phase transformations, Prentice Hall of India Pvt. Ltd., 1992.
4. K. Fisher, Fundamentals of Solidifications, 3rd Ed., Trans Tech Publications, 1989.
5. Hubert I. Aaronson, Masato Enomoto, Jong K. Lee, Mechanisms of Diffusional Phase Transformations in Metals and Alloys, CRC Press, Taylor and Francis Group.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	none
19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	none
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	None
20.2	Open-ended problems	None
20.3	Project-type activity	One course project will be assigned towards the end of the semester
20.4	Open-ended laboratory work	None
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	MICRO & NANOSCALE MECHANICAL BEHAVIOUR OF MATERIALS
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	APL763
6.	Status (<i>category for program</i>)	Departmental elective

7.	Pre-requisites (<i>course no./title</i>)	none
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supercedes any existing course	no

9.	Not allowed for (<i>indicate program names</i>)	none
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. Rajesh Prasad, Dr. Jayant Jain, Dr. Anamika Prasad, Dr. Ajeet Kumar	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): This course will deal with the fundamental aspects of mechanical behaviour of materials at micro and nanoscale. It will utilise the basic concepts of bonding, dislocations and mechanics. The course will help in understanding of the existing materials as well as to develop materials for future engineering challenges. The course is designed to cover the behaviour of materials at multiple length scales (i.e. from macro scale to nano scale). A comprehensive view on mechanical behaviour of engineering materials will be provided.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Elastic anisotropy of crystalline materials, defects in crystals: point defects and interfaces, dislocations and analysis of plasticity, geometric and energetic aspects of dislocations, microscale mechanisms of plastic deformation such as slip and twinning, single and polycrystal deformation, crystallographic textures, theory of work hardening in crystals, strengthening mechanisms in crystals,	
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	nanoscale testing of materials: in-situ SEM/TEM, nanoindentation, nano-wear, correlation of nanoscale measured response to macroscale response of materials
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction	1
2	Elastic anisotropy of crystalline materials	3
3	Defects in crystals: point defects and interfaces	3
4	Defects in crystals: Dislocations and analysis of plasticity	3
5	Geometric and energetic aspects of dislocations	4
6	Microscale mechanisms of plastic deformation such as slip and twinning	4
7	Single crystal and polycrystal deformation	4
8	Crystallographic textures	4
9	Work hardening in crystals	2
10	Other strengthening mechanisms	4
11	Nanoscale testing of materials: in-situ SEM/TEM, nanoindentation, nano-wear	5
12	Correlation of nanoscale measured response to macroscale response of materials	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

There is no additional slot for tutorials. However, as per the need, few lab hours may be converted into full-fledged tutorial class.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Tensile testing of Materials	3
2	Mechanical working of materials	3
3	Softening behaviour of materials	3
4	Measurement of crystallographic textures using XRD	3
5	Microscale indentation response of materials: Instrumented Microindenter	3
6	Nanoscale indentation response of materials: Nanoindenter	3
7	Measurement of wear at nanoscale: Scratch testing	3
8		
9		
10		
COURSE TOTAL (14 times 'P')		21

18. Suggested texts and reference materials

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

1. W. F. Hosford, Mechanical Behaviour of Materials, 2nd ed., Cambridge University Press, 2010.
2. Hull and Bacon, Introduction to Dislocations, 4th Ed., Butterworth and Heinemann, Oxford, 2001.
3. A.Kelly and N.H.Macmillan, Strong Solids, 3rd Ed., Oxford Science Publications, 1987.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	none
19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	Materials characterization, Materials testing
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	None
20.2	Open-ended problems	None
20.3	Project-type activity	One course project will be assigned towards the end of the semester
20.4	Open-ended laboratory work	None
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	BIOMATERIALS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	APL764
6.	Status (<i>category for program</i>)	Departmental elective

7.	Pre-requisites (<i>course no./title</i>)	none
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	BML820/Biomaterials (10%)
8.3	Supercedes any existing course	no

9.	Not allowed for (<i>indicate program names</i>)	none
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. Rajesh Prasad, Dr. Jayant Jain, Dr. Anamika Prasad, Dr.Sitikantha Roy	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): The course is designed to introduce students to the field of biomaterials with focus on mechanical property, and structure-property correlation of basic class of biomaterials, including their selection and application in certain speciality of medicine and medical devices.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction and history of biomaterials; Basic classes of engineering materials and structure property correlation; Structure and property of cells and tissues; Property requirement of biomaterials including biocompatibility, and biobegrability; Basic types of biomaterials; Mechanical testing of biomaterials; application of biomaterials (orthopedic,cardiovascular, dental) including detailed case study.	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction and History of Biomaterials	1
2	Basic Materials Science: Classes of engineering Materials (metals, Ceramics, Polymers, composites); Bulk Mechanical Properties and property-structure correlation	5
3	Introduction to structure, and property of cells, tissues, and blood	5
4	Property requirement of Biomaterials and biocompatibility, concept of biodegradable and bioresorbable, host reaction of biomaterials.	4
5	Basic types of Biomaterial: Polymers, metals (including Nitinol), ceramics, composites, hydrogels and engineered natural materials,	8
6	Mechanical and Biological testing of Biomaterials including sample preparation and handling	6
7	Application of Biomaterials: Focus on orthopedics, cardiovascular devices, dental implants.	5
8	Case Studies	3
9	Introduction to Material selection software	3
10	Student Project Presentation	2
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

There is no additional slot for tutorials.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	No additional slot for lab activities.	
2		
3		
4		
5		
6		
7		
8		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. Biomaterials Science: An Introduction to Materials in Medicine, 3rd Edition, Ratner et al., Plenum Press, Academic Press, 1996.
2. Materials Science and Engineering - An Introduction, 7th Ed, WD Callister, Jr
3. Biomaterials: An Introduction, 3rd Edition, Joon Park, RS Lakes, Springer

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	CES Edu Pack, Cambridge Materials Selector
19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	none
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	None
20.2	Open-ended problems	None
20.3	Project-type activity	One course project will be assigned mid semester with project presentation at the end.
20.4	Open-ended laboratory work	None
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	FRACTURE MECHANICS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	APL765
6.	Status (<i>category for program</i>)	Departmental elective

7.	Pre-requisites (<i>course no./title</i>)	none
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supercedes any existing course	no

9.	Not allowed for (<i>indicate program names</i>)	none
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. Rajesh Prasad, Dr. Jayant Jain, Prof. Puneet Mahajan, Dr. V. Tiwari	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): Fracture is an important way in which materials fail. To design against fracture it is important to understand the concepts of fracture mechanics. This course will equip students to use fracture mechanics tool to design better fracture resistant machines and structures.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Fracture: an overview, theoretical cohesive strength, defect population in solids, stress concentration factor, notch strengthening, elements of fracture mechanics, Griffiths crack theory, stress analysis of crack, energy and stress field approaches, plane strain and plane stress fracture toughness testing, crack opening displacement, elastic-plastic analysis, J-integral, ductile-brittle transition, impact energy fracture toughness correlation, microstructural aspects of fracture toughness, environmental assisted cracking, cyclic stress and strain fatigue, fatigue crack propagation, analysis of engineering failures	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Fracture: an overview, theoretical cohesive strength, defect population in solids, stress concentration factor, notch strengthening	5
2	Elements of fracture mechanics, Griffiths crack theory, stress analysis of crack, energy and stress field approaches, plane strain and plane stress fracture toughness testing, crack opening displacement	6
3	Elastic-plastic analysis, J-integral, ductile-brittle transition, impact energy fracture toughness correlation	7
4	Microstructural aspects of fracture toughness	6
5	Environmental assisted cracking,	5
6	Cyclic stress and strain fatigue, Fatigue crack propagation,	5
7	Analysis of engineering failures	8
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

There is no additional slot for tutorials.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. R.W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, 1976, p 229–230.
2. Anderson, T.L., Fracture Mechanics, 3rd Ed., Fundamentals and Applications, CRC Press, Taylor and Francis group, 2005.
3. H. L. Ewald and R. J. H. Wanhill, Fracture Mechanics, Edward Arnold Publishers, 1986.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	none
19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	none
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	None
20.2	Open-ended problems	None
20.3	Project-type activity	One course project will be assigned towards the end of the semester
20.4	Open-ended laboratory work	None
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Applied Mechanics
2.	Course Title (<i>< 45 characters</i>)	ENGINEERING FAILURE ANALYSIS AND PREVENTION
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	APL767
6.	Status (<i>category for program</i>)	Departmental elective

7.	Pre-requisites (course no./title)	none
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supercedes any existing course	no

9.	Not allowed for (indicate program names)	none
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Prof. Rajesh Prasad, Dr. Jayant Jain, Prof. Puneet Mahajan, Dr. V. Tiwari	
12.	Will the course require any visiting faculty?	no

13.	Course objective (<i>about 50 words</i>): Analysing failure is a critical process in determining the physical root causes of problems. The course will assist students in determining causes of failures and eliminating future failure. It will help in enhancing product quality and solving the industrial problems.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Common causes of failure, principles of failure analysis, fracture mechanics approach to failure problems, techniques of failure analysis, service failure mechanisms, ductile and brittle fracture, fatigue failure, wear failure, hydrogen induced failure, environment induced failures, high temperature failure, faulty heat treatment and design failures, processing failure (forging, casting, machining etc.), failure problems in joints and weldments, case studies for failure analysis of structural components and mechanical system	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction: Common causes of failure	4
2	Principles of failure analysis	7
3	Fracture mechanics approach to failure problems	5
4	Techniques of failure analysis	6
5	Service failure mechanisms,	6
6	Ductile and brittle fracture, fatigue failure, wear failure, hydrogen induced failure, environment induced failures, high temperature failure, faulty heat treatment and design failures, processing failure (forging, casting, machining etc.),	10
7	Failure problems in joints and weldments	2
8	Case studies for failure analysis of structural components and mechanical system	2
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

There is no additional slot for tutorials.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. ASM Handbook, Editor: W.T. Becker and R.J. Shipley, Volume 11: Failure Analysis and Prevention, 2002.
2. James J. Scutti, Introduction to Failure Analysis and Prevention, ASM International, 2002.
3. Fractography, ASM Handbook, Vol. 12, 1987.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	none
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19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	none
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	None
20.2	Open-ended problems	None
20.3	Project-type activity	One course project will be assigned towards the end of the semester
20.4	Open-ended laboratory work	None
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

Course Template: Decision Theory and Design Optimization (APL771)

1.	Department/Centre	Applied Mechanics
2.	Course Title	Design Optimization and Decision Theory
3.	Course No.	APL 771
4.	L-T-P structure	3-0-0
5.	Credits	3
6.	Status of the course	Stream elective for Product Design stream
7.	Prerequisite for the course	-
8.	Status vis-à-vis other courses	
8.1	Overlap with any UG/PG Course of the Dept./Centre	Nil
8.2	Overlap with any UG/PG Course of other Dept./Centre	Nil
8.3	Supercedes any existing course	No
9.	Not allowed For	NIL
10.	Frequency of offering	Either Semester
11.	Faculty who will teach the course	SK, BPP, MKS, AK, SP, PM, SA, SR
12.	Will the course require visiting faculty	-
13.	Course Objectives: The main objectives of the course are: formulation and solution of design optimization problems and application of decision theory for conceptual/detailed design selection problems.	
14.	Course Content: Introduction, classification of optimization problems, single variable and multi variable unconstrained optimization problems, constrained optimization, integer programming, genetic algorithms and simulated annealing, review of probability theory, decision theory.	
15.	Lecture Outline (with topics and number of lectures)	
SN.	Topic	No. of hrs
i	Introduction: Design variables, constraints, variable bounds, objective function, duality principle, statement and classification of design optimization problems.	2
ii	Single-variable optimization: bracketing methods-Eexhaustive search and bounding phase, direct search methods-Fibonacci search, Golden	5

	section search, Point estimation method; Gradient based methods-Newton-Raphson, Bisection methods.	
iii	Multi-variable unconstrained optimization: Taylor series expansion of multivariate functions, Optimality criteria, General sufficiency condition, Undirectional search, Direct search methods-Nelder-Mead simplex search, Conjugate direction method; Gradient based methods-Cauchy's steepest descent, Conjugate gradient method, Newton's method, Davidon-Fletcher-Powell (DFP) method.	7
iv	Constrained optimization: Method of Lagrange multipliers of equality constraints, Kuhn-Tucker conditions, K-T necessity and sufficiency theorems. Penalty function methods, feasible direction method, generalized reduced gradient method, Checking convergence	10
v	Integer Programming- Penalty function method, Branch and bound method	2
vi	Genetic algorithm and simulated annealing	4
vii	Review of probability theory - Bernoulli trial, Binomial, Poisson distributions, Gaussian, Exponential, Gamma distributions, Joint probability, marginal and conditional distributions, expectations, co-variance	3
vii	Decision Theory - Design under risk-Expected value criteria, Expected value-variance criteria, Experimental data in decision, Decision trees, Decision under uncertainty- Laplace, Minimax, Savage, Hurwicz criteria	8
viii	Multi-objective optimization	1
	Course total	42
16.	Brief description of tutorial activities	
	-	
17.	Brief description of laboratory activities:	
	-	
18.	Suggested Text and Reference Material	
	1. Optimization for Engineering Design – Algorithms and Example, Kalyanmoy Deb, Prentice Hall, 2003. 2. Engineering Optimization - Theory and Practice, S S Rao, 3 rd Ed., 2003, New age Institutional Publishers, New Delhi. 3. Introduction to Optimum Design– J. Arora, 2004, 2 nd Ed. Academic Press. 4. Introduction to Engineering Design Optimization , C. O. Onwubiko, Prentice Hall, 2000 5. Applied Optimization with MATLAB Programming- P. Venkataraman, John Wiley and Sons, 2 nd Edition, 2009 6. Operation Research-An Introduction, Hamdy A Taha, 8 th Ed. Prentice Hall, 2006.	
19.	Resources required for the course	
19.1	Software	Matlab, Mathematica
19.2	Hardware	-

19.3	Teaching aides (videos etc.)	-
19.4	Laboratory	-
19.5	Equipment	-
19.6	Classroom infrastructure	Projection system
19.7	Site visits	-
20.	Design Content of the course	
20.1	Design type problems	20 %
20.2	Open-ended problems	10 %
20.3	Project-type activity	10 %
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

Course Template: Modeling and Analysis of Mechanical Systems(APL774)

1.	Department/Centre	Applied Mechanics
2.	Course Title	Modeling and Analysis of Mechanical Systems
3.	Course No.	APL 774
4.	L-T-P structure	3-0-0
5.	Credits	3
6.	Status of the course	Stream elective for Product Design stream
7.	Prerequisite for the course	-
8.	Status vis-à-vis other courses	
8.1	Overlap with any UG/PG Course of the Dept./Centre	-
8.2	Overlap with any UG/PG Course of other Dept./Centre	Nil
8.3	Supercedes any existing course	No
9.	Not allowed For	NIL
10.	Frequency of offering	Either Semester
11.	Faculty who will teach the course	Prof. B.P. Patel, Dr. M.K. Singha, Dr. S. Pradyuman, Prof. S. Kapuria, Prof. S.V. Veeravalli, Dr. M.R. Cholemari, Dr. Sawan Suman
12.	Will the course require visiting faculty	-
13.	Course Objectives: The main objective of the course is to introduce modeling and analysis of components/systems relevant for preliminary/detailed design of products through analytical and experimental techniques.	
14.	Course Content: Introduction, constitutive modeling of elastic orthotropic, elasto-plastic isotropic, and viscoelastic isotropic solids. Plane stress problems in polar coordinate system, bending of rectangular plates-Navier and Levy's solution, bending of circular plates, membrane theory of shells, bending of cylindrical shells, vibration and buckling of rectangular plates. Flow measurement, velocity measurement, multi-hole probes and optical measurements. External flows, boundary layers (laminar and turbulent); estimation of lift and drag, internal flows, application to pipe lines.	

15.	Lecture Outline (with topics and number of lectures)	
SN.	Topic	No. of hrs
i	Introduction	1
ii	Constitutive modeling of elasto-plastic isotropic and viscoelastic isotropic solids	3
iii	Plane stress problems in polar coordinate system	3
iii	Bending of rectangular plates-Navier and Levy's solution	4
iv	Axisymmetric and asymmetric bending of circular plates	3
v	Membrane theory of shells	3
vi	Bending of cylindrical shells	2
vii	Free vibration and buckling of rectangular plates	4
viii	Flow measurement, velocity measurement, multi-hole probes and optical measurements.	6
ix	External flows, boundary layers (laminar and turbulent); estimation of lift and drag,	6
x	Internal flows, application to pipe lines.	6
xi	Introduction to modeling of smart products-sensors and actuators	1
	Course total	42
16.	Brief description of tutorial activities	
	-	
17.	Brief description of laboratory activities:	
	-	
18.	Suggested Text and Reference Material	
	1. Theory of Plates and Shells by S.P. Timoshenko and S.W.-Krieger, Tata McGraw Hill (2010). 2. Vibrations of Shells and Plates by Werner Soedel, Marcel Dekker (2004). 3. Buckling of Bars, Plates and Shells by Brush and Almorth, McGraw Hill (1975). 4. Experimental Fluid Mechanics, Tropea et al, Springer Verlag, 2007 5. Viscous Fluid Flow, F. M. White, McGraw Hill, 3rd edition, 2007	
19.	Resources required for the course	
19.1	Software	-

19.2	Hardware	-
19.3	Teaching aides (videos etc.)	-
19.4	Laboratory	-
19.5	Equipment	-
19.6	Classroom infrastructure	White board, projection system
19.7	Site visits	-
20.	Design Content of the course	
20.1	Design type problems	20 %
20.2	Open-ended problems	10 %
20.3	Project-type activity	10 %
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

Course Template: Design Methods (APL775)

1.	Department/Centre	Applied Mechanics
2.	Course Title	Design Methods
3.	Course No.	APL 775
4.	L-T-P structure	3-0-0
5.	Credits	3
6.	Status of the course	Core for PG Program
7.	Prerequisite for the course	-
8.	Status vis-à-vis other courses	
8.1	Overlap with any UG/PG Course of the Dept./Centre	Nil
8.2	Overlap with any UG/PG Course of other Dept./Centre	Nil
8.3	Supersedes any existing course	No
9.	Not allowed For	NIL
10.	Frequency of offering	Either Semester
11.	Faculty who will teach the course	BPP, DKS, SVV, SA.
12.	Will the course require visiting faculty	Yes
13.	Course Objectives: The main objectives of the course are to formulate technical specification of conceptual design problem, concept design, concept selection and testing, detailed functional design and analysis, forecast of new technology development.	
14.	Course Content: Introduction, design cycle, need analysis, product specifications, quality function deployment (QFD), concept generation, concept selection, TRIZ, concept testing, preliminary design, architecture design. Modeling, sensitivity, compatibility, stability analyses. Design for manufacturing, material, maintenance and safety. Industrial design, detailed design, prototype/model testing. Axiomatic design. Detailed Drawings/Assembly Drawings/ Assembly Instructions /Maintenance Manuals, Case Studies.	
15.	Lecture Outline (with topics and number of lectures)	
SN.	Topic	No. of hrs
i	Introduction and design cycle	2
ii	Need analysis, engineering specifications and QFD	3

iii	Concept generation	4
iv	Concept selection	2
v	Theory for inventive problem solving (TRIZ)	6
vi	Concept testing	2
vii	Preliminary design, architecture design	4
vii	Modelling Techniques-Mathematical, Graphical, iconic, solid etc.	2
viii	Sensitivity, compatibility, stability analyses.	1
ix	Design for manufacturing, material, maintenance and safety	5
xi	Design for reliability	2
xii	Design for sustainability and environment	2
xiv	Detailed drawings/assembly drawings /assembly /maintenance manuals	1
xv	Case studies	6
	Course total	42
16.	Brief description of tutorial activities	
	-	
17.	Brief description of laboratory activities:	
	-	
18.	Suggested Text and Reference Material	
	1. The engineering design process by Alita Ertas & J. C. Jones, John Wiley & Sons (1996). 2. Design Engineering: Inventiveness, analysis and decision making by J. R. Dixon, McGraw Hill Book Company (1966). 3. Introduction to Design by Morris Asimow, Prentice Hall Inc. (1962). 4. Design Methods (journal). available in www.sciencedirect.com . 5. Product Design and Development by Karl T Ulrich & S. D. Eppinger, Tata Mc-Graw Hill, New Delhi (2003). 6. Engineering Design by GE Dieter, McGraw-Hill (2000).	
19.	Resources required for the course	
19.1	Software	Cambridge Engineering Selector
19.2	Hardware	-
19.3	Teaching aides (videos etc.)	-
19.4	Laboratory	-

19.5	Equipment	-
19.6	Classroom infrastructure	Projection system
19.7	Site visits	-
20.	Design Content of the course	
20.1	Design type problems	40 %
20.2	Open-ended problems	20 %
20.3	Project-type activity	10 %
20.4	Open-ended laboratory work	Nil
20.5	Others (please specify)	Nil

Date:

(Signature of the Head of the Department)

Course Template: Product Design and Feasibility Study

1.	Department/Centre	Applied Mechanics
2.	Course Title	Product Design and Feasibility Study
3.	Course No.	APL 776
4.	L-T-P structure	2-0-4
5.	Credits	4
6.	Status of the course	
7.	Prerequisite for the course	None
8.	Status vis-à-vis other courses	
8.1	Overlap with any UG/PG Course of the Dept./Centre	No
8.2	Overlap with any UG/PG Course of other Dept./Centre	No
8.3	Supersedes any existing course	AMP772 and AMP776
9.	Not allowed For	
10.	Frequency of offering	Once in a year
11.	Faculty will teach the course	D. K. Sehgal, S. N. Singh, V. Tiwari, M. K. Singha, B. P. Patel
12.	Will the course require visiting faculty	No
13.	Course Objectives: Student should develop a scientific approach to do the feasibility study for the launch of a new innovative product, keeping into mind the human factors involved. He has to do the complete design and fabrications of the new product proposed.	
14.	Course Content – Prefeasibility Study, Market Analysis-Development of Sales Plan. Technical Analysis- Development of Manufacturing Plan. Financial Analysis-Develop General and Administrative Plan, Evaluate Project Feasibility, Preparation of project Proposal. Human Factors in Design, Human factors and systems, Information input, Human output and control, Workplace Design, environmental conditions, human factors applications.	
15.	Lecture Outline (with topics and number of lectures)	
SN.	Topic	No. of hrs
1.	Prefeasibility Study	3

2	Market Analysis	3
3	Technical Analysis	4
4	Financial Analysis	4
5	Human factors and systems	2
6	Information Input	2
7	Human output and control	3
8	Workplace Design	2
9	Enviromental conditions	2
10	Human factors Applications	3
	Course Total	28
16.	Brief description of tutorial activities	
17.	Brief description of laboratory activities:	
SN.	Experiment Description	Hours
1	Development of Feasibility report-	14
2	Product Design and Fabrication	42
	Total	56
18.	Suggested Text and Reference Material	
	1. Project Feasibility Analysis by Clifton and Fyffe, Johnwiley, 1977	
	2. Human Factors in engineering and Design by Sanders and McCormick, McGraw Hill, 1992	
19.	Resources required for the course	
19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos etc.)	
19.4	Laboratory	Fabrication facilities
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20.	Design Content of the course	
20.1	Design type problems	25%
20.2	Open-ended problems	
20.3	Project-type activity	25%
20.4	Open-ended laboratory work	
20.5	Others (please specify)Fabrication	50%

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	APPLIED MECHANICS
2.	Course Title (<i>< 45 characters</i>)	Advanced Solid Mechanics
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	APL796
6.	Status (<i>category for program</i>)	Elective for Engineering Mechanics stream

7.	Pre-requisites (<i>course no./title</i>)	Continuum Mechanics
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supercedes any existing course	Continuum Mechanics

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course: Prof. Puneet Mahajan, Dr. Ajeet Kumar, Dr. S. Roy, Dr. M.K. Singha, Prof. B.P. Patel	
12.	Will the course require any visiting faculty?	None

13.	Course objective (<i>about 50 words</i>): The primary objective of the course is to introduce students to advanced topics of solid mechanics, e.g., nonlinear elasticity, plasticity, wave propagation, thermodynamic constitutive modeling etc.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Large deformation kinematics, lagrangian stress and strain tensors, balance laws in lagrangian framework, nonlinear constitutive modeling, nonlinear theory of beams and buckling, wave propagation, theory of plasticity, solution of elasticity problems – contact modeling, multiscale modeling etc.	
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Large deformation kinematics, Polar decomposition theorem	2
2	Lagrangian stress and strain tensors	1
3	Derivation of balance laws in lagrangian framework	2
4	Constitutive modeling – Frame-indifference, material symmetry, invariants of strains, thermodynamic consistency, concept of internal variables with application to damage mechanics, plasticity etc.	8
5	Wave propagation	5
6	Nonlinear beam theory and buckling	3
7	One-dimensional plasticity of bars and beams, torsion, residual stress and shakedown	3
8	Haigh-Westergaard coordinates, Yield surface shape, Tresca criterion, von-Mises criterion, Anisotropic yield criterion, Application to thick cylinders	5
9	Drucker stability postulate, convexity of Yield surface, Flow rule, isotropic and kinematic hardening, elasto-plastic stiffness, visco-plasticity, Numerical implementation	7
10	Strain space formulation	2
11	Advanced topics – contact modeling, multiscale modeling etc.	4
		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Moduleno.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. A.J.M. Spencer, Continuum Mechanics, Dover publishers, 1980
2. K.F. Graff, Wave motion in elastic solids, Dover publishers, 1991
3. L.M. Kachanov, Fundamentals of the theory of plasticity. Dover, 2004

B. References

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	White Board, Projection
19.7	Site visits	

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

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

+COURSE TEMPLATE

1.	Department /Centre proposing the course	APPLIED MECHANICS	
2.	Course Title (<i>< 45 characters</i>)	THEORY OF PLATES AND SHELLS	
3.	L-T-P structure	3-0-0	
4.	Credits	03	
5.	Course number	APL831	
6.	Status (<i>category for program</i>)	PE for M.Tech. (Engineering Mechanics) and OE for others	
7.	Pre-requisites (course no./title)		
8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	-Nil-	
8.2	Overlap with any UG/PG course of other Dept./Centre	-Nil-	
8.3	Supercedes any existing course	-None-	
9.	Not allowed for (<i>indicate program names</i>)		
10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
11.	Faculty who will teach the course: S. Kapuria, M K Singha, B. P. Patel, S. Roy		
12.	Will the course require any visiting faculty?	-No-	
13.	Course objective (<i>about 50 words</i>): The objective of this course is to introduce the students with (a) <i>the two-dimensional theories for the analysis of common thin-walled structural elements of engineering structures and equipments</i> , and (b) <i>their solutions by analytical and numerical methods for the deformation and stresses of plates, cylindrical shells, spherical domes, conical shells and pressure vessels</i> .		
14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Basic assumptions of two-dimensional theories, Theory of surfaces, Strain-displacement relations in shell coordinates, Stress-resultants, General governing equations of motion, Boundary conditions. Analytical solutions for bending and vibration of rectangular plates and circular plates. Approximate solution techniques. Membrane theory and its applicability, Membrane and general bending solutions cylindrical, conical and spherical shells, and pressure vessels. Selected problems on the stability. Design considerations.		

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

Module	Topic	No. of
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no.		hours
01	Introduction: Basic assumptions of two-dimensional theories vis-à-vis three dimensional elasticity	02
02	Theory of Surfaces: First and Second Fundamental Forms of Surfaces, Normal to a Surface, Principal Curvatures, Derivatives of Tangent and Normal Vectors, Fundamental Theorems, Classification of Shells.	04
03	Fundamental Equations of Theory of Shells: Shells Coordinates, Strain-Displacement Relations, Stress Resultants, General Equations of Motion using Hamilton's Principle, Boundary Conditions.	07
04	Bending and Vibration of Rectangular Plates: Navier Solution, Levy Solution, Approximate Solutions Techniques	08
05	Bending and Vibration of Circular Plates	03
06	Membrane Theory of Shells: Conditions of Applicability of Membrane Theory, Membrane Shells of Revolution- Cylindrical, Spherical, Conical	04
07	General Bending of Circular Cylindrical Shells	05
08	Bending Stresses in Conical and Spherical Shell and Pressure vessels, Cylindrical-to-Hemispherical head junctions.	05
09	Introduction to Stability of Plates and Shells.	02
10	Special Topics: Presentations by Students	02

16. Brief description of tutorial activities

Nil

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

1. J. N. Reddy, *Theory and Analysis of Elastic Plates and Shells*, CRC Press, 2007.
2. Harry Kraus, "Thin Elastic Shells", John Wiley & Sons.
3. S. Timoshenko, S. Woinowsky-Krieger, *Theory of Plates and Shells*, McGraw-Hill, 1959.
4. T. K. Varadan and K. Bhaskar, *Analysis of Plates: Theory and Problems*, Narros Publishing House, 1999.
5. Werner Soedel, "Vibrations of Shells and Plates" –, Marcel Dekker Inc, 3rd Edition
6. A. C. Ugural, "Stresses in Beams, Plates and Shells" CRC Press, 3rd Ed. 2009

7. M.Farshad, *Design and Analysis of Shell Structures*, Springer, 1992.
8. P. L. Gould, *Analysis of Shells and Plates*, Springer, 1988.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	MATLAB
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projector
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

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

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

Mechanics of Composite Materials (APL835)

1.	Department /Centre /School proposing the course	Applied Mechanics		
2.	Course Title	Mechanics of Composite Materials		
3.	L-T-P structure	3-0-0		
4.	Credits	3	Non-graded Units	-
5.	Course number	APL 835		
6.	Course Status (Course Category for Program)			
	Institute Core for all UG programs		(No)	
	Programme Linked Core for:		-	
	Departmental Core for:		-	
	Departmental Elective for:		Solid Mechanics Stream	
	Minor Area / Interdisciplinary Specialization Core for:		-	
	Minor Area / Interdisciplinary Specialization Elective for:		-	
	Programme Core for:		-	
	Programme Elective for:		-	
	Open category Elective for all other programs (No if Institute Core)		(Yes)	

7.	Pre-requisite(s)	-
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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	N/A
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	N/A
8.2	Supersedes any existing course		N/A

9.	Not allowed for	N/A
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10.	Frequency of offering (check one box)	☐ Either semester
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11.	Faculty who will teach the course: VT, PM, SA, SK, SP, MKS, BPP
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12.	Will the course require any visiting faculty? No
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13.	Course objectives (about 50 words. "On successful completion of this course, a student should be able to..."): The main objective of the course is to introduce students to the mechanics of composites, Design, fabrication, evaluation and applications of the composites.
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14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): Composites, Various reinforcement and matrix materials, Strength and stiffness properties, Effective moduli, Spherical inclusions, Bio-composites, cylindrical and lamellar systems, Laminates: Laminated plates, Analysis and Design with composites, Fiber reinforced pressure vessels, dynamic, inelastic and non-linear effects, Fabrication of composites, Machining of composites, Strength evaluation, Technological applications.
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1.	Introduction.	1
2.	Solid mechanics - Principal Stresses, Plane stress, Principal Strain, Plane strain, Compatibility relationship, Homogenous materials, Isotropic materials, Orthotropic materials, Anisotropic materials, Transversely isotropic materials.	4
3.	Fibers, Matrix, Representative Volume Element, Tensors, Stress transformations, Stiffness matrix, Compliance matrix.	5
4.	Laminates, Symmetric laminates, Antisymmetric laminates, Asymmetric laminates, Classical laminate theory and other theories,	5
5.	Temperature and moisture residual stresses, prediction of stiffness and failure.	5
6.	Design and Fabrication of various composites.	4
7.	Machining techniques for composites.	3
8.	Modes of failure, different failure criterion, inelastic and non-linear effects.	5
9.	Strength evaluation, Technological applications and environmental effects.	5
10.	Advanced topics and recent developments in composites.	5

Total Lecture hours(14 times 'L')	42
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16. Brief description of tutorial activities: N/A

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

17. Brief description of Practical / Practice activities: N/A

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
1.	Application of composites in Space.
2.	Application of composites in Defense.
3.	Application of composites in Human Implants.
4.	Cost benefits Vs Metals.

(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. Mechanics Of Composite Materials (Materials Science & Engineering Series) by Robert M Jones. CRC Press; 2 edition (4 February 2015).
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2. Principles of Composite Material Mechanics, Third Edition (Mechanical Engineering)
by Ronal F Gibson.CRC Press; 3 edition (26 October 2011)

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

20.1	Software	-
20.2	Hardware	-
20.3	Teaching aids (videos, etc.)	-
20.4	Laboratory	-
20.5	Equipment	-
20.6	Classroom infrastructure	White board, projection system.
20.7	Site visits	Composites Lab. of the Department of Applied Mechanics.
20.8	Others (please specify)	

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

21.1	Design-type problems	30%
21.2	Open-ended problems	10%
21.3	Project-type activity	10%
21.4	Open-ended laboratory work	Nil
21.5	Others (please specify)	Term Paper – 10%

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

1.	Department /Centre proposing the course	Applied Mechanics	
2.	Course Title (<i>< 45 characters</i>)	SELECTED TOPICS IN MATERIALS SCIENCE AND ENGINEERING	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	APL858	
6.	Status (<i>category for program</i>)	Stream elective	

7.	Pre-requisites (course no./title)	none	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	None	
8.2	Overlap with any UG/PG course of other Dept./Centre	None	
8.3	Supercedes any existing course	no	

9.	Not allowed for (indicate program names)	none	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Prof. Rajesh Prasad, Dr. Jayant Jain		
12.	Will the course require any visiting faculty?	no	

13.	Course objective (<i>about 50 words</i>): This course will cover selected and advanced topics of recent interest not covered in other courses		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): The course content will be decided by the instructor		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

There is no additional slot for tutorials.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	none
19.2	Hardware	none
19.3	Teaching aides (videos, etc.)	none
19.4	Laboratory	none
19.5	Equipment	none
19.6	Classroom infrastructure	White board, Projection system
19.7	Site visits	none

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

20.1	Design-type problems	None
20.2	Open-ended problems	None
20.3	Project-type activity	None
20.4	Open-ended laboratory work	None
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)

1.	Department /Centre proposing the	Applied Mechanics
2.	Course Title (< 45 characters)	Product Reliability
3.	L-T-P structure	3-0-0
4.	Credits	3.0
5.	Course number	APL871
6.	Status (category for program)	Open

7.	Pre-requisites (course no./title)	None
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8.	Status vis-à-vis other courses (give course number/title)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	15% (Reliability Maintainability and Availability) ITL711
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	None
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course: SA, BPP,PM	
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (about 50 words):To present a unified view of the techniques and theory for the analysis and prediction of reliability of a product /structure using probabilistic approach with due consideration of uncertainties associated with material and loads. Address the target safety and reliability requirements as per design codes. Reliability based design optimization and safety assessment of existing systems.	
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14.	Course contents (about 100 words) (Include laboratory/design activities): Reliability; basic concepts , Uncertainty in engineering systems; Modeling, Multiple random variables, product failure theories, Failure models, Limit state function, Probability distribution, PDF & CDF, Evaluation of joint probability distribution, Markov Process, Stochastic Finite Element Analysis, Randomness in response variables, First and higher order methods for reliability assessment, Deterministic & probabilistic approach , Risk based design, Central limit theorem, load and resistance approach, Fault tree approach, system reliability, stress strength interference method, Monte-Carlo and other simulation techniques, Regression analysis, Software based reliability analysis, Sensitivity analysis and reliability based design optimization, international standards, Applications & case studies	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basic concepts- need for safety and reliability assessment, system uncertainties, statistical and probabilistic models, stress and strength correlation, limit state function.	05
2	Modeling of uncertainty, multiple random variables, joint distributions, PDF & CDF, Probability distributions.	05
3	Stochastic Finite Element analysis, randomness in response variables, Deterministic & probabilistic approach for reliability analysis.	05
4	Load and resistance approach. Product failure theories, system reliability, Fault tree analysis, stress strength interference, joint probability distribution, Random data simulation techniques, regression analysis.	05
5	Markov Process, Statistical models and quantifications, Analytical models, co-relation coefficients, statistical confident levels.	04
6	Evaluation of joint probability distribution, Central Limit Theorem, load and resistance approach. Risk based design, Risk and safety factor approach.	04
7	Reliability assessment methods: stress strength interference, Monte-Carlo simulation, FORM, and AFOSM.	04
8	Second order reliability method, correlated variables, nonlinear system reliability, Hasofer Lind method, Response surface methods (RSM), GRSM.	04
9	Software based reliability analysis, Sensitivity analysis and reliability based design optimization, international standards. applications and case studies.	06
		42

16. Brief description of tutorial activities**17. Brief description of laboratory activities**

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		

COURSE TOTAL (14 times 'P')	
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18. Suggested texts and reference materials

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

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| <ol style="list-style-type: none"> 1. Practical reliability engineering, Patrick D.T. O'CONNOR , David Newton, Richard Bromley John Willy & Sons , 4th Edition, 2008 2. Response Surface Methodology, Raymond H. Myers, Douglas C. Montgomery, John Willy & Sons , 3rd Edition, 2009 3. Reliability Assement using Stochastic finite element analysis , Achinytya Haldar and Sanker Mahadevan , John Willy & Sons , 2000 4. Probability, reliability and statistical methods in engineering design, Achinytya Haldar and Sanker Mahadevan John Willy & Sons, 2000 5. Structural reliability analysis and prediction, R. E. Melchers , John Willy & Sons, 2nd Edition, 1999 6. Reliability engineering, L.S Srinath Fourth Edition ,East West Press, 4th Edition, 2005 7. Probability Concepts in Engineering, Alfred Ang & Wilson Tang, John Willy & Sons , 2nd Edition, 2006 |
|---|

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	NESSUS , ABAQUS, ANSYS
19.2	Hardware	None
19.3	Teaching aides (videos, etc.)	None
19.4	Laboratory	None
19.5	Equipment	None
19.6	Classroom infrastructure	Black board, Projection system
19.7	Site visits	None

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

20.1	Design-type problems	5% - 8%
20.2	Open-ended problems	5 %
20.3	Project-type activity	10 %
20.4	Open-ended laboratory work	5 %
20.5	Others (please specify)	none

Date:

(Signature of the Head of the Department)