

Proposed Structure of M.Tech. (Production Engineering):

Category	Core	Electives	Total
Credits	31	18	49

List of Core Courses

S.No.	Title	L-T-P	Credits
1	Machining Processes and Analysis	3-0-2	4
2	Welding Science and Technology	3-0-2	4
3	Metal Forming Analysis	3-0-2	4
4	Computer Aided Manufacturing	3-0-2	4
5	Computational Methods	2-0-0	2
6	Metrology	2-0-2	3
7	Experimental Methods	3-0-2	4
8	Major Project Part-1	0-0-12	6

List of Electives

S.No.	Title	L-T-P	Credits
1	Casting Technology	3-0-2	4
2	Additive Manufacturing	3-0-2	4
3	Automation in Manufacturing	3-0-2	4
4	Processing and Mechanics of Composite Materials	3-0-2	4
5	Advances in Metal Forming	3-0-0	3
6	Surface Engineering	3-0-2	4
7	Design and Metallurgy of Welded Joints	3-0-2	4
8	Finite Element Method	3-0-2	4
9	Machine Tool Design	3-0-2	4
10	Product Design and Manufacturing	1-0-4	3
11	Mechatronic Product Design	3-0-2	4
12	Industrial Engg. and Systems	1-0-4	3
13	Quality Systems	3-0-2	4
14	Operations Planning and Control	3-0-0	3
15	Advanced Machining Processes	3-0-0	3
16	Manufacturing Informatics	3-0-0	3
17	Injection Molding and Mold Design	2-0-2	3
18	Process Engineering	2-0-4	4
19	Major Project Part-2	0-0-24	12

M. Tech in Production Engineering

[illegible]

COURSE TEMPLATE

1.	Department/Centre proposing the course	Mechanical Engg
2.	Course Title (< 45 characters)	ADVANCED MACHINING PROCESSES
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	NA
6.	Status (category for program)	PG ELECTIVE, DE FOR ME1 & ME2

7.	Pre-requisites (course no./title)	MFG-2 FOR ME1, MATERIAL REMOVAL PROCESSES FOR ME2
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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	
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 Dr P. M. Pandey, Dr. S. Jha, Prof P V Rao, Dr S. Ghosh,
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12.	Will the course require any visiting faculty?	NO
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13.	Course objective (about 50 words):With advances in materials science new exotic materials are being developed and many of these materials needs to be shaped properly for appropriate use. The traditional machining processes like turning, milling, drilling etc. cannot be used for machining these materials. Hence advanced machining processes like ultrasonic machining, abrasive flow machining, magnetic abrasive finishing, electrochemical grinding etc. have to be used to shape and fabricate the engineering components.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Introduction to advanced machining processes – need for such processes and application areas
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	<i>Mechanical Energy utilized advanced machining processes like ultrasonic machining, abrasive flow machining, magnetic abrasive finishing, magneto-rheological finishing, abrasive water jet machining – mechanics of cutting, process parametric analysis, process capabilities, applications</i> <i>Thermoelectric based advanced machining processes like electro discharge machining, wire EDM, Plasma Arc Machining, Laser Beam Machining, Focussed Ion Beam Machining – working principles, material removal mechanisms, process capabilities and applications</i> <i>Electrochemical and Chemical Advanced Machining – ECG, Electrostream Drilling, Chemical Machining – process characteristics, numerical modelling of the processes, applications and limitations</i>
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Need for advanced machining processes, classification of the processes based on energy requirement	1
2	Mechanical Energy utilized Advanced Machining Processes – Abrasive Jet Machining – machining set up, principle of operation, mechanisms of material removal, parametric analysis, process capabilities and applications	2
3	Ultrasonic Machining Process – Basic Machining set up and description, mechanics of cutting, parametric analysis, modelling of material removal rate, process capabilities, applications, limitations of the process	3
4	Waterjet Machining – set up, process characteristics and process performance, applications and limitations, Abrasive Water jet Machining – set-up, basic working principle, different variants, process variables, process performance, analysis and modelling for material removal, applications and limitations	4
5	Magnetic Abrasive Finishing – working principle of MAF, magnetic particles normally used in the process, different process variables and their significance, modelling of material removed and surface finish, applications	2
6	Magneto-rheological Finishing – working principle, composition of MR polishing fluid, process parameters, material removal and surface finish modeling, variants of the process MRF, MRAFF, MRJF, Ball end MRF etc.	3
7	Thermoelectric based Advanced Machining Processes – Electro Discharge Machining (Die sinking) – Introduction, working principle, different types of circuits used in EDM Machine, Analysis of RC circuits, Modelling for Material Removal rate and surface finish in die sinking EDM, process variables and characteristics, applications	3
8	Wire EDM – working principle, basic machining setup, types of wire drive systems, different materials used as wires, process variables, process characteristics, applications	2
9	Plasma Arc Machining – working principle, plasma arc cutting system and its various elements, transferred and non transferred arc variants,	2

	applications and limitations	
10	Laser Beam Machining – Various types of lasers and their basic working principles, process characteristics, applications	4
11	Focused Ion Beam Machining – working principle, FIB Machining system, parametric analysis, applications	2
12	Electro chemical and Chemical Advanced Machining Processes – Electrochemical machining – Introduction, the process of electrolysis and the laws associated with it, types of electrolytes used in ECM, ECM Machine and its different modules, feed rate control in ECM, applications, advantages and limitations	5
13	Electrochemical Grinding – ECG Machine set up, process characteristics and applications	2
14	Electrostream Drilling – Introduction, process performance, applications	2
15	Chemical Machining – Introduction, maskants, etchants, numerical process modelling including tool design, advantages and limitations	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

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

1. Advanced Machining Methods by JAMcGeough, Chapman and Halls, UK. 2. Advanced Machining Processes by V.K.Jain, Allied Publishers, New Delhi. 3. Unconventional Machining Processes by P.K.Mishra Institution of Engineers 4. Modern Machining Processes by P.C.Pandey and H.S. Shan, Tata McGraw Hill, New Delhi.
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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	----
19.7	Site visits	----

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

20.1	Design-type problems	Design content depends on the individual projects.
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	Mechanical Engg
2.	Course Title (<i>< 45 characters</i>)	ADVANCES IN METAL FORMING
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	NA
6.	Status (<i>category for program</i>)	PG ELECTIVE, DE FOR ME 1 AND ME 2

7.	Pre-requisites (course no./title)	MANUFACTURING –I FOR ME 1 (CORE) METAL FORMING AND PRESS TOOLS FOR ME 2 (CORE)
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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	20% with PG core course on metal forming
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
8.3	Supercedes any existing course*	MEL 335

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 D. Ravi Kumar	
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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 teach advanced and recent technological developments in metal forming processes and equipment and their applications and make the students learn design of tools for metal forming processes using analytical methods and computer aided tools.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Advanced metal forming processes such as tube and sheet hydroforming, High energy rate forming processes such as EMF, EHF and explosive forming. Design of dies for forging, extrusion and wire drawing, Die design for sheet metal forming processes such as single and multi-stage deep drawing, bending and stretch forming. Materials used for making forming tools, Lubrication mechanisms, Metal forming equipment, Formability testing of sheet metals, Determination of Forming Limit Diagrams and	
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	their applications, Warm forming, Micro forming.
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Lecture Outline *(with topics and number of lectures)*

15.

Module no.	Topic	No. of hours
1	Advanced metal forming processes such as tube and sheet hydroforming.	4
2	High energy rate forming processes such as EMF, EHF and explosive forming.	4
3	Die design for forging, extrusion and wire drawing	4
4	Die design for sheet metal forming processes	4
5	Materials used for forming tools and their heat treatment	3
6	Lubrication mechanisms in metal forming	3
7	Metal forming equipment	4
8	Formability testing of sheet metals	3
9	Determination of Forming Limit Diagrams and their applications.	3
10	Tailor welded blanks and their applications	3
11	Warm forming	3
12	Microforming and its applications	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

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

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|---|
| 1. Applied Metal Forming, Henry S. Valberg, Cambridge, 210. |
| 2. Sheet Metal Forming Processes and Applications, T. Altan and Tekkaya, ASM, 2012. |

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

19.1	Software	Modelling and metal forming simulation softwares
19.2	Hardware	---
19.3	Teaching aides (videos, etc.)	---
19.4	Laboratory	---
19.5	Equipment	----
19.6	Classroom infrastructure	Yes
19.7	Site visits	----

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

20.1	Design-type problems	20%
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	Mechanical Engg
2.	Course Title (<i>< 45 characters</i>)	AUTOMATION IN MANUFACTURING
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	NA
6.	Status (<i>category for program</i>)	PG Elective, DE FOR ME1 AND ME2

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	30% with MEL334
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supercedes any existing course*	MEL783

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 Sunil Jha
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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 this course is to develop good understanding about various components of state of art automation technologies encountered in modern manufacturing industries. It introduces to the basic control systems used to automate manufacturing processes, practical methods of automatic control of machines, processes and systems. All major parts of a modern industrial control and automation systems will be described and their principles explained. Application of automation technologies for modern manufacturing industries will also be covered.
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14.	Course contents <i>(about 100 words) (Include laboratory/design activities):</i> Introduction to Automation of different manufacturing processes. Types of systems - mechanical, electrical, electronics; Data conversion devices, transducers, signal processing devices, relays, contactors and timers. Sensors and their interfaces; Hydraulics & Pneumatic Systems design and their application to manufacturing equipment; Sequence operation of hydraulic and pneumatic cylinders and motors; Electro Pneumatic & Electro Hydraulic Systems design, Relay Logic circuits, Feedback control systems, PID Controller; Drives and mechanisms of an automated system: stepper motors, servo drives. Ball screws, linear motion bearings, electronic camming and gearing, indexing mechanisms, tool magazines, and transfer systems. Programmable Logic Controllers, I/Os, system interfacing, ladder logic, functional blocks, structured text, and applications. Human Machine Interface & SCADA; Motion controller and their programming, PLCOpen Motion Control blocks, multi axes coordinated motion, CNC control; RFID technology and its application; Machine vision and control applications. Modular Production Systems – Distribution, Conveying, Pick & Place etc. Laboratory work will be hands-on design and operation of automatic systems.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1.	Introduction to Automation of different manufacturing processes, need of automation and components.	1
2.	Types of automated systems – Hydraulic, pneumatic, mechanical, electrical, electronics	1
3.	Data conversion devices, transducers, signal processing devices, relays, contactors and timers, Sensors and their interfaces	5
4.	Hydraulics & Pneumatic Systems design and their application to manufacturing equipment, Control Components - Pressure, Flow rate, Direction control valves.	5
5.	Hydraulic System Analysis, Sequence operation of more than two cylinders and motors	3
6.	Electro-pneumatics circuit design, Relay control, Sequence control of a lifting device, Terminal Allocation	4
7.	Programmable Logic Controllers, Electrical connection diagram, I/O interfacing, E stop circuits, programming languages & instruction set, ladder logic, Timers, Counters, functional blocks, structured text, and applications. Motion control functions and PID loop control using PLC	7
8.	Feedback control systems – P, PI, PID Controller and their implementation	3
9.	Drives and mechanisms of an automated system: Motion controller programming, PLCOpen Motion Control blocks, stepper & servo	6

	motors, multi axes coordinated motion, CNC control	
10	Ball screws, linear motion bearings, electronic camming and gearing, indexing mechanisms, tool magazines, and transfer systems.	2
11.	Visualization through Human Machine Interface (HMI) design & SCADA, Screen design and implementation	3
12.	RFID technology and its application in Manufacturing	1
13.	Machine vision and process control applications	1
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1.	Advance Pneumatics – circuit design, simulation and implementation	5
2.	Electro Pneumatics – circuit design, simulation and implementation	5
3.	Electro Hydraulics experiments	2
4.	Proportional Hydraulics experiments	2
5.	Programmable logic controller – programming, interfacing and implementation	5
6.	Sensors and their interfaces	2
7.	Motion controller programming, Electronic Camming & Gearing	3
8.	HMI Screen development and SCADA	2
9.	RFID & Machine vision	2
COURSE TOTAL (14 times 'P')		28

18. Suggested texts and reference materials

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

1.	Anthony Esposito, Fluid Power with Applications, Sixth Edition, Pearson Education, 2009
2.	John W. Webb & Ronald A. Reis, Programmable Logic Controllers – Principles and Applications, Fifth Edition, Pearson Education, 2008
3.	Michael J. Pinches & John G Ashby, Power Hydraulics, Prentice Hall International (UK) Ltd.
4.	John R. Hackworth & Frederick D. Hackworth Jr, Programmable Logic Controllers – Programming Methods and Applications, Pearson, 2011
5.	B C Nakra, Theory and Applications of Automatic Controls, Revised 2 nd Edition, New Age International Publishers, 2014
6.	W. Bolton, Mechatronics, 4 th Edition, Pearson Education, 2014

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

19.1	Software	Festo Fluid SIM, Automation Studio, RS Logix 500, RS
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		Lofix 5000, Factory Talk Studio ME & SE edition, HMI Design, Motion control software
19.2	Hardware	Pneumatic Trainer, Electro pneumatic trainer, Electro Hydraulic trainer, Proportional hydraulic trainer, PLC Trainer Boards, Linear slides, motors, motion controller, sensors, RFID reader, camera
19.3	Teaching aides (videos, etc.)	Web based tutorials, Hydraulics & Electro hydraulics video
19.4	Laboratory	Automation Lab
19.5	Equipment	Modular Production Systems
19.6	Classroom infrastructure	----
19.7	Site visits	Factory visits

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

20.1	Design-type problems	Design content depends on the individual projects.
20.2	Open-ended problems	20%
20.3	Project-type activity	20%
20.4	Open-ended laboratory work	10%
20.5	Others (please specify)	Design and simulation of automated systems – 20%

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1. **Department/Centre proposing the course** Mechanical Engineering
2. **Course Title** CASTING TECHNOLOGY
(< 45 characters)
3. **L-T-P structure** 3 - 0 - 0
4. **Credits** 3
5. **Course number** NA
6. **Status** ELECTIVE
(category for program)

7.	Pre-requisites (course no./title)	None
8. Overlap of contents with any (give course number/title)		
8.1	existing UG course(s) of the Department/Centre	
8.2	proposed UG course(s) of the Department/Centre	None
8.3	approved PG course(s) of the Department/Centre	None#####
8.4	UG/PG course(s) from other Departments/Centers	None#####
8.5	Equivalent course(s) from existing UG course(s)	None#####
9.	Not allowed for (indicate program names)	
10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Alternate year
11.	Faculty who will teach the course S. ARAVINDAN,	
12.	Will the course require any visiting faculty?	MAY BE
13.	Course objective (about 50 words): The objective of the course is to understand the advances in casting technologies. The solidification behaviour of metals, fluidity aspects, grain structure and related mechanical properties are analysed. Near net shaping processes are introduced.	
14.	Course contents (about 100 words) (Include laboratory/design activities): Sand casting: sand molding techniques, Core sand and core fabrication Other casting: Permanent mold, pressure die casting, squeeze casting,	

	centrifugal casting, continuous casting, stir casting, defects and inspection. Gating system, risering system, casting design: Metallurgical consideration, design consideration, economical consideration. Fluidity testing, Application of CAD\CAM in foundry. Casting of complicated shapes: automotive components, casting of light alloys – Aluminum, magnesium and Titanium alloys Advances in near net shape manufacturing: Metal Injection moulding, Laser engineered net shaping.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Cooling curves, solidification behaviour of metal and alloy, dendritic, equi axed and refined grain structure and associated mechanical properties	3
2	Types of sands, sand properties, sand control tests, sand preparation, sand molding techniques, core manufacturing	6
3	Inoculation, types of cast iron – microstructure, properties and applications	2
3	Permanent mold, pressure die casting, squeeze casting, centrifugal casting, continuous casting, stir casting, investment casting, shell moulding	6
4	Gating system, risering system, casting design: Metallurgical consideration, design consideration, economical consideration	6
5	Application of CAD\CAM in foundry. Casting of complicated shapes: automotive components, casting of light alloys – Aluminum, magnesium and Titanium alloys.	6
6	Fluidity tests, melt quality tests, fluxing and flushing methods for melt quality. Defects – porosity, inclusions, dross, bi films and their remedies,	5
7	Composite casting, single crystal casting-turbine blades	3
8	Metal injection moulding and applications	2
9	Laser engineered net shaping and applications	2
10	Casting yield and cost analysis	1
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Not Applicable

17. Brief description of laboratory activities

Modul eno.	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: Sonntag, R. E., Borgnakke, C., and Van Wylen, G. J., *Fundamentals of Thermodynamics*, 5th Ed., John Wiley, 2000.

1.	Manufacturing Engineering and Technology – Kalpakjian (Addison Wesley)
2.	Principles of Metal Casting – RW Heine, CR Loper and PC Rosenthal (Tata-McGraw Hill)
3.	Manufacturing Science – A. Ghosh and A.K. Mallik (East West Press)
4.	ASM handbook on casting technology
5.	Materials and processes in manufacturing – E.Paul degarmo- wiley 2002
6.	Fundamentals of Modern Manufacturing: Materials, Processes & Systems by Mikell P. Grover, Mikell P. Groover –Prentice Hall USA.

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

19.1	Software	MOLD FLOW SIMULATION SOFTWARE
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
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

1.	Department/Centre proposing the course	Mechanical Engg
2.	Course Title (<i>< 45 characters</i>)	DESIGN AND METALLURGY OF WELDED JOINTS
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	NA
6.	Status (<i>category for program</i>)	PG ELECTIVE

7.	Pre-requisites (course no./title)	NIL
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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	NIL
8.3	Supercedes any existing course*	MEL

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 Dr S. Aravindan, Prof.Sunil Pandey	
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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>): This course introduces the design aspects of welding in fabrication. It facilitates the students to understand the problems and difficulties in obtaining a sound welded structure and its analysis, joint preparation procedures, Weld Procedure specification (WPS), joining metallurgy and microstructures. It orients the students to understand the effects of alloying materials, heat flow in welds, heating and cooling cycles in welds, development of phases, microstructure etc..	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Importance of welding in fabrication, Problems and difficulties in welded structures, service and fabrication tests and their importance, weld testing and qualification, causes and remedies for weld defects, weld symbols, weld joint design for strength	
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3	Pre and post weld heat treatment and micro structural analysis of joints- ferrous and non ferrous materials.	4
4	Non destructive testing of joints	1
COURSE TOTAL (14 times 'P')		14

18. Suggested texts and reference materials

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

AWS D 1.1 STRUCTURAL WELDING CODE
 ASME SECTION VIII & IX.
 Howard B. Cary, Modern Welding Technology (6th Edition) 2004
 ASM Handbook:: Welding, Brazing, and Soldering Vol 6, 1993.
 Welding science and technology Vol.1, AWS Handbook, 9th edition, AWS, Miami,FL.

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	----
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	Mechanical Engg
2.	Course Title (< 45 characters)	INJECTION MOULDING AND MOLD DESIGN
3.	L-T-P structure	2 - 0 - 2
4.	Credits	3
5.	Course number	NA
6.	Status (category for program)	PG Elective, DE FOR UG (ME1 and ME2)

7.	Pre-requisites (course no./title)	MFG-I for ME1 and Near Net Shape Mfg for ME2
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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	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	Nil
8.3	Supercedes any existing course*	MEL792

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 Naresh Bhatnagar
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12.	Will the course require any visiting faculty?	NO
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13.	Course objective (about 50 words): The modern manufacturing industries cannot be complete without Injection moulding process. Most of the automotive, general engineering, white goods and commodity products are made of plastics requiring Injection moulding process for near net shape product realization for mass manufacturing. This course will tease students to become entrepreneur by understanding the science of converting polymer melt into a product of desired shape , size and tolerances.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Introduction to Injection molding fundamentals, flow of non-Newtonian fluids, flow of various polymer melts in a cavity, molding cycle, injection molding machine characteristics- injection unit design, clamping unit design, shrinkage, warpage,
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	<i>defect free product, Moldflow analysis – fundamentals of FE analysis for fill, cool, warp, stress, DOE, results interpretation. Mold design fundamentals, type of molds- two plate, three plate, feeding system – sprue, runner, gate design, ejection system - pin, sleeve, stripper plate, air ejection design. Moldings with undercuts – internal, external, threads, split cavity, split core designs. Advances in injection molding process- microcellular, gas assisted, insert, outsert, push-pull, multilive, vibration assisted, micro lamellar, lost core. Designing with plastics, applications and future research.</i>
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Introduction of Injection Molding Cycle. Types of thermoplastics, properties required for injection molding. Types of injection molding machines, specifications of shot size and clamping tonnage, mold locking.	3
2	Injection molding process – fundamentals of polymer flow in a cavity, viscosity temperature relations, pressure temperature relations, residual stresses, shrinkage vs warpage, molding defects and remedies	8
3	Plastics mold design, product considerations, mold bases, mold size and strength, moldability- automatic removal of parts, sprue, runner system, gate sizes and type, gate location, weld line, air traps, jetting, vents, undercuts. Mold design details- ejection system, cavities and cores, molding inserts, split cores, split cavities, mold bases, two plate vs three plate mold, hot runners, runnerless moldings. Mold cooling system design- channels, types, heat content, coolant passages, effect of temperature variation in mold	8
4	Moldflow analysis- Finite element fundamentals of flow for non-Newtonian fluids, governing material models- power law, cross wolf. Meshing of solid part model, analysis for fill, cool, warp, stress, etc. Design of experiments, best gate location, weld line, air trap predictions and remedies, flow leaders and deflectors, vent locations	4
5	Advances in Injection Molding techniques and its variants - Microcellular, gas assisted, insert, outsert, vibration, push-pull, multilive, micro lamellar, micro injection, metal injection, lost core, in-mold decoration etc.	4
6.	Designing of plastic products for injection molding	1
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Injection molding fundamentals- Conventional NC machine	4
2	Injection molding fundamentals- Microcellular Machine	2
3	Injection molding fundamentals- Microinjection Machine	2
4	Mold design and fabrication project (open ended with Moldflow analysis of plastic part)	20
5		
6		
7		
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. David Kazmer, Injection Mold Design Engineering, Hanser, 2007
2. J.P.Beaumont, R. Nagel, R. Sherman, Successful Injection Molding,- Process, Design and Simulation, 1st ed. Hanser, 2002.
3. JYH Fuh, M.W Fu, AYC Nee, Computer Aided Injection Mold Design and Manufacture, 1st ed. Marcel Dekker, 2004

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

19.1	Software	Moldflow™ (Available)
19.2	Hardware	Injection molding Machines (available)
19.3	Teaching aides (videos, etc.)	Yes
19.4	Laboratory	Yes
19.5	Equipment	Yes
19.6	Classroom infrastructure	Projection/ video/audio
19.7	Site visits	Yes

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

20.1	Design-type problems	100% Design content on the individual open ended projects.
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20.2	Open-ended problems	Always new product design and manufacturing
20.3	Project-type activity	Yes
20.4	Open-ended laboratory work	Yes
20.5	Others (please specify)	Entrepreneurship possibilities

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Mechanical Engg
2.	Course Title (< 45 characters)	MECHATRONIC PRODUCT DESIGN
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	NA
6.	Status (category for program)	PG ELECTIVE, DE FOR ME1 & ME2

7.	Pre-requisites (course no./title)	Mechatronics UG course
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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	
8.2	Overlap with any UG/PG course of other Dept./Centre	EEL482 (30%)
8.3	Supercedes any existing course*	MEL749

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 Sunil Jha
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (about 50 words):Introduction to mechatronic components and systems design. Mechanical and Embedded electronics design, mechatronic system design approach. Engineering and economical aspects of mechatronic product design, PCB Design, Enclosure design, prototyping tools, design verification and testing, selection of various components in the product design, Firmware development. This course build capability to design basic mechatronic products.
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14.	Course contents (about 100 words) (Include laboratory/design activities):Introduction tokey elements ofMechatronic products - Physical Systems Modeling, Sensors and
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	Actuators, Signals and Systems, Computers and Logic Systems, Software and Data Acquisition; Mechatronic Design Approach, System Interfacing, Instrumentation and Control Systems; Microprocessor-Based Controllers and Microelectronics; Product functional block diagram, schematic and PCB Design, Product enclosure design, Microcontroller interfacing and programming, Interfacing with sensors and actuators, driver circuits, motion control, Stepper and servo motion control. Software and hardware tools to build mechatronic systems. Design and selection of mechatronic elements namely sensors like encoders and resolvers; stepper and servomotors, ballscrews, solenoid like actuators, and controllers with applications to CNC systems, robotics, consumer electronic products etc. Design of a mechatronic product using available software CAD packages. Laboratory work will be hands-on Microcontroller & Microprocessor interfacing and programming, Motion controller, motors, sensors, and actuators
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1.	Introduction to key elements of Mechatronic products	1
2.	Physical Systems Modeling	2
3.	Sensors and Actuators	2
4.	Signals and Systems	2
5.	Software and Data Acquisition	2
6.	Mechatronic Design Approach, System Interfacing, Instrumentation and Control Systems	3
7.	Microprocessor-Based Controllers and Microelectronics	3
8.	Product functional block diagram, schematic and PCB Design, Product enclosure design	4
9.	Microcontroller interfacing and programming, Interfacing with sensors and actuators, driver circuits, motion control, Stepper and servo motion control	8
10.	Software and hardware tools to build mechatronic systems	3
11.	Design and selection of mechatronic elements namely sensors like encoders and resolvers; stepper and servomotors, ballscrews, solenoid like actuators, and controllers	4
12.	Mechatronics applications to CNC systems, robotics, consumer electronic products etc.	4
13.	Design of a mechatronic product using available software CAD packages.	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1.	Mechatronic product analysis	4
2.	Sensors Experiments	2
3.	Actuators	2
4.	Microcontroller programming Software	4
5.	Microcontroller programming for various interfaces	4
6.	Motion Control using stepper & servo motors	2
7.	Microcontroller based measurement and control: D/A and A/D conversion, data acquisition systems	4
8.	Product design and manufacturing	6
COURSE TOTAL (14 times 'P')		28

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. Bolton W, Mechatronics: Electronic Control Systems in Mechanical Engineering, 4th Edition, Pearson Education, 2008 2. Robert H. Bishop, The Mechatronics Handbook, 2nd Edition, CRC Press, 2002 |
|---|

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

19.1	Software	Microcontroller C Compiler & IDE, Assembler, CAD Software
19.2	Hardware	Microcontroller Evaluation Boards, PC, Interface boards for Display, keypad, LCD, Motors, Sensors etc.
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	Mechatronics / Automation Lab
19.5	Equipment	PCB Manufacturing, 3D Printer, Soldering
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%
20.2	Open-ended problems	20%
20.3	Project-type activity	30%
20.4	Open-ended laboratory work	20%
20.5	Others (please specify)	---

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Mechanical Engg
2.	Course Title (<i>< 45 characters</i>)	PROCESSING AND MECHANICS OF COMPOSITE MATERIALS
3.	L-T-P structure	3 - 0 - 2
4.	Credits	4
5.	Course number	NA
6.	Status (<i>category for program</i>)	ELECTIVE

7.	Pre-requisites (<i>course no./title</i>)	NIL
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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	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	Nil
8.3	Supercedes any existing course*	MEL791

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 Naresh Bhatnagar
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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>): This course on composite materials processing focuses on manufacturing of fiber reinforced plastic composites (FRP), macromechanics and micromechanics of lamina leading to laminate and structural analysis of orthotropic material system. Further, this course aims at enabling the PG/UG students to understand and design a composite material product based on either polymer, ceramic and metal based composites.
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): <i>Introduction to matrix materials - polymers, metals and ceramics. Introduction to reinforcements – fibers, flakes, particulates: macro, micro and nano. Hand layup, tape layup, autoclave moulding, vacuum bag moulding, compression moulding, resin</i>
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	<i>transfer moulding, reaction injection moulding, filament winding, pultrusion, braiding, and other manufacturing variants. Macromechanics of a lamina as a building block of a composite structure, stress-strain relation, strain –stress relation for anisotropic material, orthotropic materials, material property matrix estimation, micromechanics of a lamina, effect of fiber volume fraction on properties, failure theories of a lamina. Laminate analysis, failure of a laminate, design principles of tailor made material systems.</i>
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Introduction – Material world	1
2	Introduction of polymer and its mechanical properties, thermoset vs thermoplastics.	2
3	Introduction of reinforcing fibers- glass, carbon , kevlar etc. and its manufacturing techniques, long vs short reinforcements	2
4	Manufacturing processes for FRP composites- Prepregs, SMC, BMC/ DMC, layup, autoclave moulding, vacuum bag moulding, compression moulding, resin transfer moulding, reaction injection moulding, filament winding, pultrusion, braiding, elastic reservoir moulding, and other manufacturing variants	6
5	Macromechanics of a lamina- Anisotropy, orthotropy, quasi isotropy, material constants evaluation, in plane vs out of plane properties, stress –strain relations for each material type, transformation of stresses and strains, coefficients of mutual influence, experimental evaluation of properties in 3 directions.	8
6	Failure theory/ phenomenon of composite materials – Max. stress, Max. strain, Tsai- Hill, Tsai-Wu, Hoffman, etc. fiber orientation	4
7	Micro mechanics of a lamina – critical fiber length, continuous vs random fiber lamina stress- strain relationship, Halphin-Tsai equations for prediction of material constants	4
8	Macromechanics of a Laminate- A, B, D stiffness matrices, failure theory application, algorithm of stress analysis of a composite laminate	6
9	Designing with FRP composites	4
10	Metal Matrix Composites- manufacturing methods, analysis of property predictions	2
11	Ceramic Matrix Composites – manufacturing methods, analysis of property predictions	2
12	Applications of Advance materials – Design for manufacturing	1
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Hand - layup	2
2	Specimen preparation – tensile, shear, compression	2
3	Testing fixtures demonstration	2
4	Testing of samples for laminate properties	2
5	Compression Moulding – Laminate/ product manufacturing	2
6	Pultrusion (at Industry)	2
7	Mini project – open ended to realize a composite product	16
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. Robert. M Jones. *Mechanics of Composite Materials, Material Science and Engineering Series. 2nd Edition, CRC press, Feb 2015.*
2. AK Kaw. *Mechanics of Composite Materials. 2nd Edition, CRC Press, New York, 2006*
3. P.K. Mallick *Fiber-Reinforced Composites: Materials, Manufacturing, and Design, Third Edition (Mechanical Engineering), CRC press, Nov 2007*

Others

- <http://composite.about.com/>
- <http://www.netcomposites.com/>
- <http://www.e-composites.com/>
- <http://www.compositesone.com/basics.htm>
- <http://www.wvcomposites.com/> (World Wide Search Engine for Composites)
- <http://www.eirecomposites.com/>
- <http://www.advanced-composites.co.uk/>
- http://www.efunda.com/formulae/solid_mechanics/composites/comp_intro.cfm

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

19.1	Software	YES (Laminator/ Ansys/ Abacus/ Solidworks)
19.2	Hardware	YES (Pultrusion, Filament winding, RTM, RIM needed Compression moulding-available)
19.3	Teaching aides (videos, etc.)	Yes
19.4	Laboratory	Yes

19.5	Equipment	Yes
19.6	Classroom infrastructure	Projection/ video/ audio
19.7	Site visits	Yes

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

20.1	Design-type problems	100 %
20.2	Open-ended problems	YES 100%
20.3	Project-type activity	YES, team of 2 to 3
20.4	Open-ended laboratory work	YES
20.5	Others (please specify)	Ultimate product/ process realization of non-isotropic materials

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Mechanical Engg
2.	Course Title (< 45 characters)	SURFACE ENGINEERING
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	New PG Elective
6.	Status (category for program)	DE FOR ME1 AND ME 2

7.	Pre-requisites (course no./title)	NIL
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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	NIL
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL
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 Dr S. Aravindan, Dr S. Ghosh	
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12.	Will the course require any visiting faculty?	NO
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13.	Course objective (about 50 words): Failure of many engineering components occur due to extreme surface stresses or by wear and corrosion during service life. Such failures may be prevented and the service life of the components may be improved by suitably changing the surface properties. Surface engineering is thus a multidisciplinary activity whose aim is to tailor the surface properties such as reflectivity, fatigue and wear, corrosion and oxidation so that the function and serviceability of the components can be enhanced. The course is intended to encourage the students to use advanced surface engineering techniques like laser, plasma spray, cold spray etc. to suitably tailor the surface properties.	
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14.	Course contents (about 100 words) (Include laboratory/design activities): <i>Introduction to surface engineering – importance and scope of surface engineering, conventional surface engineering practices like pickling, grinding, buffing etc., surface engineering by material addition like electroplating, surface modification of ferrous and non ferrous materials like nitriding, cyaniding, aluminizing etc.</i> <i>Advanced surface engineering practices like laser assisted surface modification, electron beam assisted modification, spraying techniques like flame and plasma spraying, high velocity oxyfuel, cold spray techniques.</i> <i>Sputter deposition processes, PVD and CVD methods of surface coatings, surface modification by ion implantation and ion beam mixing</i> <i>Characterisation of the engineered surface and coatings like thickness, porosity and adhesion of coatings, surface microscopy and spectroscopic analysis of the modified surfaces.</i> <i>Functional coatings and their applications.</i>
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Fundamentals of surface engineering – surface dependent properties and reasons for failures, importance and scope of surface engineering	2
	Surface and surface energy – types of surface interfaces and relevant surface energy equations	1
2	Conventional surface engineering practices – cleaning, pickling, etching, grinding, buffing etc.	2
	Surface engineering by material addition like hot dipping, electrodeposition / plating / electroless coating	1
	Surface modification of ferrous and non ferrous components – pack carburizing, aluminizing, calorizing, diffusion coatings, cyaniding, nitriding etc	3
3	Advanced Surface Engineering Practices – surface engineering by energy beams, classification and general principles, types and energy/intensity deposition profile	1
	Laser assisted microstructural modification – surface melting, hardening etc.	2
	Surface alloying of steels and non ferrous alloys by energy beams	1
	Surface cladding, composite surfacing and similar techniques for surface compositional modification	1
	Electron Beam and Ion Beam assisted surface modification (both microstructural and compositional)	2
	Surface Coating techniques – Plasma Spray Process, HVOF, Cold Spray – principles and scope of applications	3
	Techniques for characterization of surface microstructure and brief operating principles of those techniques,	2
4	Thin film surface coatings – sputter deposition of thin films, DC, RF, Magnetron and Ion Beam	4
	PVD coating processes and their applications	2
	CVD process and its applications	2

	Ion implantation method	1
5	Characterization of coatings – measurement of thickness, porosity, adhesion strength, residual stresses, spectroscopic analysis of modified surfaces etc. Quality testing of coating(ASTM)	6
6	Functional coatings and their applications – nano structured coatings, surface passivation of semiconductors and effect on the electrical properties, surface engineering of polymers and composites, thin films for optical and magnetic devices and their applications	6
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

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

18. Suggested texts and reference materials

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

1. Surface Engineering & Heat Treatment By: P.H Morton I.I.T, Brooke field, (1991)
2. Materials and Surface Engineering Edited by J. Paulo Davim, Woodhead Publishing, February, 2012.
3. Surface Engineering of Metals by Tadeusz Burakowski, Tadeusz Wierzchon, CRC Press, Taylor and Francis Group
4. Introduction to Surface Engineering and Functionally Engineered Materials by Peter Martin, John Wiley and Sons.
5. ASM handbook Vol. 5 : Surface Engineering

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	----
19.7	Site visits	----

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

20.1	Design-type problems	Design content depends on the individual projects.
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)