Ref No:

SRI KRISHNA INSTITUTE OF TECHNOLOGY BANGALORE

COURSE PLAN

Academic Year 2019-20

Program:	B E – Mechanical Engineering
Semester :	8
Course Code:	17ME653
Course Title:	**METAL FORMING**
Credit / L-T-P:	3/3-0-0
Total Contact Hours:	50
Course Plan Author:	Mr. Harendra Kumar H V

Academic Evaluation and Monitoring Cell
#29, Hesaraghatta Main road, Chimney Hills, Chikkabanavara P.O.,
Bengaluru – 560090, Karnataka, INDIA
Phone / Fax :+91 80 23721477 -STD- 080 23721315>

http://www.skit.org.in: skit1princi@gmail.com: >

Table of Contents

Note : Remove “Table of Content” before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

15ME653: METAL FORMING

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	ME
Year / Semester :	3rd /6th	Academic Year:	2019-20
Course Title:	METAL FORMING	Course Code:	17ME653
Credit / L-T-P:	3/3-0-0	SEE Duration:	180 Minutes
Total Contact Hours:	40	SEE Marks:	60 Marks
CIA Marks:	40	Assignment	2 / Module
CoursePlan Author:	Mr. Harendra Kumar H V	Sign	Dt:
Checked By:	Mr. Parmesha M	Sign	Dt:

2. Course Content

Module	Module Content	Teaching Hours	Module Concepts	Blooms Level
1	Introduction to Metal Forming: Classification of metal forming processes, advantages and limitations, stress-strain relations in elastic and plastic deformation. Concepts of true stress, true strain, triaxial & biaxial stresses. Determination of flow stress,principal stresses, yield criteria and their significance, Tresca & Von-Mises yield criteria, concepts of plane stress & plane strain. Deformation mechanisms, Hot and Cold working processes and its effect on mechanical properties	10	mechanical properties	L2 understand
2	Effects of Parameters: Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, Effects of Temperature, strain rate,friction and lubrication, hydrostatic pressure in metalworking, Deformation zone geometry, workability of materials, Residual stresses in wrought products. Forging: Classification of forging processes. Forging machines equipment. Expressions for forging pressures& load in open die forging and closed die forging by slab analysis, concepts of friction hill and factors affecting it. Die-design parameters. Material flow lines in forging,forging defects, residual stresses in forging. Simple problems.	10	Manufacturing process	L2 understand
3	Rolling: Classification of rolling processes. Types of rolling mills, expression for rolling load. Roll separating force. Frictional losses in bearing, power required in rolling, effects of front & back tensions, friction, friction hill. Maximum possible reduction. Defects in rolled products. Rolling variables. Simple problems. Drawing:Drawing equipment & dies, expression for drawing load by slab analysis, power requirement. Redundant work and its estimation, optimal cone angle & dead zone formation, drawing variables, Tube drawing, classification of tube drawing. Simple problems.	10	Manufacturing process	L2 understand
4	Extrusion:Types of extrusion processes, extrusion equipment & dies, deformation, lubrication & defects in extrusion. Extrusion dies, extrusion of seamless tubes. Extrusion variables. Simple problems. Sheet Metal Forming: Forming methods, dies & punches, progressive die, compound die, combination die. Rubber forming. Open back inclinable press (OBI press), piercing, blanking, bending, deep drawing, LDR in drawing, Forming limit criterion, defects of drawn products, stretch forming. Roll bending & contouring. Simple problems.	10	Manufacturing process	L2 understand

5	High Energy Rate Forming Methods &Powder Metallurgy: High Energy Rate Forming Methods: Principles, advantages and applications, explosive forming, electro hydraulic forming, Electromagnetic forming. Powder Metallurgy: Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders,compaction and sintering application of powder metallurgy components, advantages and limitations.	10	Manufacturing process	L2 understand

3. Course Material

Module	Details	Available
1	Mechanical metallurgy (SI Units), G.E.Dieter, McGraw hill Pub-2001.	In Lib
2	Production Technology (Manufacturing process, technology and Automation), R.K Jain, Khanna Publishers-2004	In Lib
3	Manufacturing Science, Amithabh Gosh &A.K.Malik, East-West press 2001	In Lib
4	Production Technology Vol-II by O. P. Khanna & Lal, Dhanpat Rai Publications-2012.	In Lib
5	A Course in Workshop Technology Vol: 1, Manufacturing Process, B.S Raghuwanshi, Published by Dhanpat Rai & Co (P) Ltd.-2014.	In Lib

4. Course Prerequisites

SNo	Course Code	Course Name	Module / Topic / Description	Sem	Remarks	Blooms Level
1	17ME32	MATERIAL SCIENCE	Plastic deformation , true stress and true strain , mechanical properties	III	-	L2 understand

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

B. OBE PARAMETERS

1. Course Outcomes

Student able to

#	COs	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
1	Able to understand the concept of different metal forming process	05	mechanical properties	Lecture	Assignment ,IA ,unit test	L2 understand
2	Able to approach metal forming processes both analytically and numerically	05	Manufacturing process	Lecture	Assignment ,IA ,unit test	L2 understand
3	Able to design metal forming processes	05	Manufacturing process	Lecture	Assignment ,IA ,unit test	L2 understand
4	Able to develop approaches and solutions to analyze metal forming processes and the associated problems and flaws.	05	Manufacturing process	Lecture	Assignment ,IA ,unit test	L2 understand
5	Able to high energy rate forming methods.	05	Manufacturing process	Lecture	Lecture & ppt	L2 understand

Note: Identify a max of 2 Concepts per Module. Write 1 CO per concept.

2. Course Applications

SNo	Application Area	CO	Level

1	Forming process is used for production of aerospace industries.	CO1	L2
2	For design of deferent parts of automobile.	CO2	L2
3	This is used for casting of different metal to maintain temperature.	CO3	L2
4	Forging is used in making turbine rotor, generator rotor Parts such as crankshaft, camshaft ,gears are made by forging operation.	CO4	L2
5	To obtain different grain size of casting.	CO5	L2
6	Drawing isused in production of tubes and metal wires.	CO6	L2
7	Extrusion is widely used in production of tubes and hollow pipes.	CO7	L2
8	Sheet metal is used in the home appliance industry to create freezers, hoods, and sinks.	CO8	L2
9	This is used for casting of different metal to maintain temperature.	CO9	L2
10	To obtain different grain size of casting.	CO10	L2

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO9	PO1 0	PO1 1	PO1 2	Level
15ME653.1	Understand concept of different metal forming process,mechanical properties	√	-	-	-	-	-	-	-	-	-	-	-	L2
15ME653.3	Under stand concept of Metallurgical aspects,metal forging processes both analytically and numerically	√	-	-	-	-	-	-	-	–	-	-	-	L2
15ME653.5	Understand concept of metal rolling processes both analytically and numerically,metal drawing processes both analytically and numerically	√	-	-	-	-	√	-	-	-	-	-	-	L2
15ME653.7	Understand concept of metal extrusion processes both analytically and numerically,sheet metal processes both analytically and numerically	√	-	-	-	-	√	-	–	-	–	-	-	L2
15ME653.9	Develop approaches to analyze metal forming methods and associated problem,Powder metallurgy aspects	√	-	-	-	-	√	-	-	-	-	-	-	L2
Note: Mention the mapping strength as 1, 2, or 3														

4. Mapping Justification

Mapping		Justification	Mapping Level
CO	**PO**	**-**	**-**
CO1	PO1	Knowledge of fundamentals like traditional and non-traditional machining process.	L2
CO1	PO2	No analysis no mapping	L2
CO1	PO3	No design and development content. No Mapping	L2
CO1	PO4	No investigation and interpretation content,No mapping	L2
CO1	PO5	No tool content no mapping	L2
CO1	PO6	No social and cultural issues,No mapping	L2
CO1	PO7	No environmental contexts,No mapping	L2

CO1	PO8	No ethical principals,No mapping	L2
CO1	PO9	No individual and team work,No mapping	L2
CO1	PO10	No Mapping	L2
CO1	PO11	No Mapping	L2
CO1	PO12	No mapping	L2
CO2	PO1	Knowledge of constructional features, performance parameters required	L2
CO2	PO2	No analysis no mapping	L2
CO2	PO3	No design and development content. No Mapping	L2
CO2	PO4	No investigation and interpretation content,No mapping	L2
CO2	PO5	No tool content no mapping	L2
CO2	PO6	No social and cultural issues,No mapping	L2
CO2	PO7	No environmental contexts,No mapping	L2
CO2	PO8	No ethical principals,No mapping	L2
CO2	PO9	No individual and team work,No mapping	L2
CO2	PO10	No Mapping	L2
CO2	PO11	No Mapping	L2
CO2	PO12	No mapping	L2
CO3	PO1	understand constructional features and performance of ECM.	L2
CO3	PO2	No analysis no mapping	L2
CO3	PO3	No design and development content. No Mapping	L2
CO3	PO4	No investigation and interpretation content,No mapping	L2
CO3	PO5	No tool content no mapping	L2
CO3	PO6	Educate students about environmental and safety issues.	L2
CO3	PO7	No environmental contexts,No mapping	L2
CO3	PO8	No ethical principals,No mapping	L2
CO3	PO9	No individual and team work,No mapping	L2
CO3	PO10	No Mapping	L2
CO3	PO11	No Mapping	L2
CO3	PO12	No mapping	L2
CO4	PO1	Knowledge of constructional features and performance of EDM.	L2
CO4	PO2	No analysis no mapping	L2
CO4	PO3	No design and development content. No Mapping	L2
CO4	PO4	No investigation and interpretation content,No mapping	L2
CO4	PO5	No tool content no mapping	L2
CO4	PO6	Educate students about environmental and safety issues.	L2
CO4	PO7	No environmental contexts,No mapping	L2
CO4	PO8	No ethical principals,No mapping	L2
CO4	PO9	No individual and team work,No mapping	L2
CO4	PO10	No Mapping	L2
CO4	PO11	No Mapping	L2
CO4	PO12	No mapping	L2
CO5	PO1	Knowledge of constructional features and performance of LBM.	L2
CO5	PO2	No analysis no mapping	L2
CO5	PO3	No design and development content. No Mapping	L2
CO5	PO4	No investigation and interpretation content,No mapping	L2
CO5	PO5	No tool content no mapping	L2
CO5	PO6	Educate students about environmental and safety issues.	L2
CO5	PO7	No environmental contexts,No mapping	L2
CO5	PO8	No ethical principals,No mapping	L2
CO5	PO9	No individual and team work,No mapping	L2
CO5	PO10	No Mapping	L2
CO5	PO11	No Mapping	L2
CO5	PO12	No mapping	L2

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					

Note: Write Gap topics from A.4 and add others also.

6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					

Note: Anything not covered above is included here.

C. COURSE ASSESSMENT

1. Course Coverage

Module #	Title	Teaching Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Metal forming process and mechanical properties	8	2	-	-	1	1	4	CO1	L2
2	Effects of Parameters: metallurgy and Forging process	8	2	-	-	1	1	4	CO2	L2
3	Rolling and drawing process	8	-	2	-	2	1	4	CO3	L2
4	Extrusion and sheet metal forming	8	-	2	-	2	1	4	CO4	L2
5	High Energy Rate Forming Methods & Powder Metallurgy	8	-	-	4	3	1	4	CO5	L2
-	**Total**	**40**	**4**	**4**	**4**	**5**	**5**	**20**	**-**	**-**

Note: Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	15	CO1, CO2,	L2, L2,
CIA Exam – 2	15	CO3, CO4,	L2, L2,
CIA Exam – 3	15	CO5	L2,
Assignment - 1	5	CO1, CO2,	L2, L2
Assignment - 2	5	CO3, CO4,	L2, L2
Assignment - 3	5	CO5	L2
Seminar - 1	-	CO1, CO2,	L2, L2
Seminar - 2	-	CO3, CO4,	L2, L2

Seminar - 3	-	CO5	L2
Other Activities – define – Slip test			
Final CIA Marks	**20**	**-**	**-**

Note : Blooms Level in last column shall match with A.2 above.

D1. TEACHING PLAN - 1

Module - 1

Title:	Introduction to metal forming	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	student should be able to:	-	**Level**
1	Understand the concept of different metal forming process	CO1	L2
2	Understand the concept of different stress -strain in metal forming	CO2	L2
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Classification of metal forming processes, advantages and limitations.	CO1	L2
2	stress-strain relations in elastic and plastic deformation.	CO1	L2
3	Concepts of true stress, true strain.	CO1	L2
4	Triaxial & biaxial stresses.	CO1	L2
5	Determination of flow stress,principal stresses.	CO1	L2
6	Yield criteria and their significance.	CO1	L2
7	Tresca & Von-Mises yield criteria.	CO1	L2
8	Concepts of plane stress & plane strain.	CO1	L2
9	Deformation mechanisms.	CO1	L2
10	Hot and Cold working processes and its effect on mechanical properties.	CO1	L2
c	**Application Areas**	**CO**	**Level**
1	Forging is used in making turbine rotor, generator rotor	CO1	L2
2	Parts such as crankshaft, camshaft ,gears are made by forging operation.	CO1	L2
d	**Review Questions**	-	-
1	With neat sketches, explain the classification of metal working process on the basis of force applied.	CO1	L2
2	Differentiate between cold working and hot working.	CO1	L2
3	Explain the concept of true stress and true strain.	CO1	L2
4	Explain Tresca's and von Mises's yield criterions.	CO1	L2
5	Obtain the relationship between (a) true strain and engineering strain and (b) true stress and engineering stress.	CO1	L2
6	Explain hot working and cold working. Mention the advantages, disadvantages and effects of hot working.	CO1	L2
7	Explain the concepts of plane stress & plane strain.	CO1	L2
8	Explain the concepts of triaxial & biaxial stresses.	CO1	L2
9	Obtain the relationship between stress-strain relations in elastic and plastic deformation.	CO1	L2
10	Explain the concepts of deformation mechanisms.	CO1	L2
e	**Experiences**	-	-
1		CO1	L2

Module – 2

Title:	Forging and their parameters	Appr	10 Hrs

		Time:	
a	***Course Outcomes***	-	**Blooms**
-	student should be able to:	-	**Level**
1	Forging equipments and their die design parameters	CO2	L2
2	Defects in forging	CO2	L2
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
11	Effects of Parameters: Metallurgical aspects of metal forming.	CO2	L2
12	Slip, twinning mechanics of plastic deformation.	CO2	L2
13	Workability of materials, Residual stresses in wrought products.	CO2	L2
14	Effects of Temperature, strain rate,friction and lubrication.	CO2	L2
15	Hydrostatic pressure in metalworking, Deformation zone geometry	CO2	L2
16	Classification of forging processes. Forging machines equipment.	CO2	L2
17	Expressions for forging pressures& load in open die forging and closed die forging by slab analysis.	CO2	L2
18	concepts of friction hill and factors affecting it.	CO2	L2
19	Die-design parameters, Material flow lines in forging,forging defects	CO2	L2
20	Residual stresses in forging. Simple problems.	CO2	L3
c	**Application Areas**	**CO**	**Level**
1	Forging is used in making turbine rotor, generator rotor	CO2	L2
2	Parts such as crankshaft, camshaft ,gears are made by forging operation.	CO2	L2
3	Extrusion is widely used in production of tubes and hollow pipes. Aluminum . Extrusion is used in structure work in many industries. This process is used to produce frames, doors, window etc. in automotive industries.	CO2	L2
4	Sheet metal is used in the home appliance industry to create freezers, hoods, and sinks.	CO2	L2
d	**Review Questions**	-	-
1	With neat sketches, explain the classification of metal working process on the basis of force applied.	CO2	L2
2	Differentiate between cold working and hot working.	CO2	L2
3	Explain the concept of true stress and true strain	CO2	L2
4	Explain the effect of the following on metal working processes: (i) Hydrostatic pressure(ii) Strain rate(iii) Friction.	CO2	L2
5	Explain briefly the formation of stresses in metal working	CO2	L2
6	Explain the probable defects obtained in forgings.	CO2	L2
7	With a neat sketch explain the working of board drop hammer	CO2	L2
8	List and explain briefly the die-design parameter in forging dies	CO2	L2
9	Write a note on material flow lines in forging.	CO2	L2
10	With a neat sketch, explain any two forging equipments	CO2	L2

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	17ME653	Sem:	VI	Marks:	30	Time:	75 minutes
Course	Metal Forming						

-	-	**Note:Answer any ONE FULL question from each Module**	**Marks**	**CO**	**Level**
1	a	Briefly explain the classification of forming process based on force applied.	7	CO1	L2
	b	Explain the following yield criterion: i) Tresca's ii) Von-Mises	8	CO1	L2
		OR			
2	a	Differentiate between cold working and hot working.	8	CO2	L2

	b	Explain the concept of true stress and true strain	7	CO2	L2
3	a	Discuss the effect of various parameters on metal working process.	7	CO1	L2
	b	Difference between cold working and hot working process.	8	CO1	L2
		OR			
4	a	With a neat sketch explain the working of board drop hammer	7	CO1	L2
	b	List and explain briefly the die-design parameter in forging dies	8	CO1	L2

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17ME653	Sem:	VI	Marks:	5	Time:	
Course:	Metal forming						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Discuss the effect of various parameters on metal working process.	5	CO1	L2
2		Difference between cold working and hot working process.	5	CO1	L2
3		Write a note on workability of materials	5	CO1	L3
4		With a neat sketch explain the working of board drop hammer	5	CO1	L2
5		List and explain briefly the die-design parameter in forging dies	5	CO1	L2
6		Write a note on material flow lines in forging.	5	CO1	L2
7		Differentiate between cold working and hot working.	5	CO1	L2
8		Explain the concept of true stress and true strain	5	CO1	L2
9		Briefly explain the classification of forming process based on force applied.	6	CO1	L2
10		b. Explain the following yield criterion: i) Tresca's ii) Von-Mises	4	CO1	L2
11		Derive the flow stress equation.	6	CO1	L2
12		With neat sketches, explain the classification of metal working process on the basis of force applied.	5	CO2	L2
13		Explain the effect of the following on metal working processes: (i) Hydrostatic pressure (ii) Strain rate (iii) Friction.	4	CO2	L2
14		With a neat sketch, explain any two forging equipments	6	CO2	L2
15		Obtain the relationship between (a) true strain and engineering strain and (b) true stress and engineering stress.		CO2	L2
16		Explain hot working and cold working. Mention the advantages, disadvantages and effects of hot working.		CO2	L2
17		Explain the concepts of plane stress & plane strain.		CO2	L2
18		Explain the concepts of triaxial & biaxial stresses.		CO2	L2
19		Obtain the relationship between stress-strain relations in elastic and plastic deformation.		CO2	L2
20		Explain the concepts of deformation mechanisms.		CO2	L2

D2. TEACHING PLAN - 2

Module – 3

Title:		Appr Time:	10Hrs
a	***Course Outcomes***	-	**Blooms**
-	student should be able to:	-	**Level**
1	Understand the rolling , drawing and extrusionprocess	CO3	L2

b	*Course Schedule*		
Class No	**Module Content Covered**	**CO**	**Level**
21	Rolling: Classification of rolling processes. Types of rolling mills, expression for rolling load.	CO3	L2
22	Frictional losses in bearing,Roll separating force.	CO3	L2
23	Power required in rolling, effects of front & back tensions, friction. Friction hill.	CO3	L2
24	Maximum possible reduction. Defects in rolled products.	CO3	L2
25	Rolling variables. Simple problems.	CO3	L2
26	Drawing:Drawing equipment & dies.Expression for drawing load by slab analysis	CO3	L2
27	Power requirement. Redundant work and its estimation.	CO3	L2
28	optimal cone angle & dead zone formation	CO3	L2
29	Drawing variables, Tube drawing,	CO3	L2
30	Classification of tube drawing. Simple problems.	CO3	L2
c	**Application Areas**	**CO**	**Level**
1	Parts such as crankshaft, camshaft ,gears are made by forging operation.	CO3	L2
2	Extrusion is widely used in production of tubes and hollow pipes. Aluminum . Extrusion is used in structure work in many industries. This process is used to produce frames, doors, window etc. in automotive industries.	CO3	L2
d	**Review Questions**	-	-
1	With neat sketch, explain different types of rolling mill arrangements.	CO3	L2
2	Explain the defects of rolled product.	CO3	L2
3	In rolling a slab from 35 to 30 nun calculate the coefficient of friction and the length of arc of contact. Take the value of roll radius as 250 mm.	CO3	L2
4	Explain the following with neat figures: i) Four high rolling mill ii) Cluster rolling mil! iii) Tandem mill iv) Planetary rolling mill	CO3	L2
5	Determine the maximum possible reduction for cold rolling of a 300 mm thick slab when = 0.8 and roll diameter 600mm . What is the maximum reduction on the same mill for hot rolling when = 0.5?	CO3	L2
6	With a neat sketch, explain planetary rolling mill.	CO3	L2
7	Calculate the rolling load if a steel is hot rolled from a 40mm thick slab of width 760mm.The reduction in thickness achieved is 30% and the roll diameter is 900mm. The plane strain flow stress is 140 MPa at the entrance and 200 MPa at the exit from the roll gap because of the increasing velocity. Assume the co -efficient of friction as 0.3. If the roll speed is 100 rpm, what is power required to drive the rolls?	CO3	L2
8	Describe the effect of front and back tension on the rolling load.	CO3	L2
9	Explain with neat sketches any three types of rolling mills. Calculate the rolling load if a steel sheet is hot rolled from a 40 mm thick slab of width 760.The reduction in thickness achieved is 30% and the roll diameter is 900 mm. The plain strain flow stress is 140 MPa at entrance and 200 MPa at the exit from the roll gap because of the increasing velocity. Assume the coefficient of friction as 0.3. If the roll speed is 100 rpm,what is power required to drive the rolls	CO3	L2
10	Explain with neat sketches the wire drawing and rod drawing operations	CO3	L2
11	Explain the defects in rolled products with neat sketches.	CO3	L2
e	**Experiences**	-	-
1			

Module – 4

Title:	**Extrusion and sheet metal forming**	Appr	10 Hrs

		Time:	
a	***Course Outcomes***	-	**Blooms**
-	student should be able to:	-	**Level**
1	Understand the Process of extrusion and sheet metal forming method	CO4	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
31	Extrusion:Types of extrusion processes,	CO4	L2
32	Extrusion equipment & dies, deformation,	CO4	L2
33	Lubrication & defects in extrusion.	CO4	L2
34	Extrusion dies, extrusion of seamless tubes.	CO4	L2
35	Extrusion variables. Simple problems.	CO4	L2
36	Sheet Metal Forming: Forming methods, dies & punches.	CO4	L2
37	Progressive die, compound die, combination die. Rubber forming.	CO4	L2
38	Open back inclinable press (OBI press),piercing, blanking, bending, deep drawing.	CO4	L2
39	LDR in drawing, Forming limit criterion, defects of drawn products, stretch forming.	CO4	L2
40	Roll bending & contouring. Simple problems.	CO4	L2
c	**Application Areas**	**CO**	**Level**
1	Extrusion is widely used in production of tubes and hollow pipes. Aluminum . Extrusion is used in structure work in many industries. This process is used to produce frames, doors, window etc. in automotive industries.	CO4	L2
2	Sheet metal is used in the home appliance industry to create freezers, hoods, and sinks.	CO4	L2
		CO4	
d	**Review Questions**	CO4	-
1	Give the classification of extrusion process and explain hydrostatic extrusion.	CO4	L2
2	Explain in detail the deformation equipments and defects in extrusion.	CO4	L2
3	Write a note on extrusion equipment and die design.	CO4	L2
4	Explain the manufacture of seamless tubes, with neat sketch.	CO4	L2
5	Give the classification of extrusion process and explain forward extrusion process with a neat sketch	CO4	L2
6	How seamless pipes and tubes can be produced by extrusion? Explain with a neat sketch.	CO4	L2
7	Briefly explain four extrusion defects with their causes and remedies.	CO4	L2
8	It is required to extrude cylindrical aluminium billet of 50mm diameter to 10mm diameter . The length of billet is 75mm and the average yield stress for aluminium material is 170N/mm^2. Calculate the force required for extrusion . Assume =0.15 and semi die- angle = 45^0.	CO4	L2
9	Give the classification of extrusion process and explain forward extrusion process with a neat sketch	CO4	L2
10	How seamless pipes and tubes can be produced by extrusion? Explain with a neat sketch.	CO4	L2
11	Explain in detail the deformation equipments and defects in extrusion.	CO4	L2
12	Briefly explain four extrusion defects with their causes and remedies.	CO4	L2
e	**Experiences**	-	-
1			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	15ME653	Sem:	VI	Marks:	20	Time:	75 minutes

Course:		Metal forming			
-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Explain in detail the deformation equipments and defects in extrusion.	8	CO3	L2
	b	Write a note on extrusion equipment and die design.	7	CO3	L2
		OR			
2	a	Give the classification of extrusion process and explain forward extrusion process with a neat sketch	7	CO4	L2
	b	How seamless pipes and tubes can be produced by extrusion? Explain with a neat sketch.	8	CO4	L2
		OR			
3	a	Give the classification of extrusion process and explain hydrostatic extrusion.	7	CO3	L2
	b	Briefly explain four extrusion defects with their causes and remedies.	8	CO3	L2
		OR			
4	a	It is required to extrude cylindrical aluminium billet of 50mm diameter to 10mm diameter . The length of billet is 75mm and the average yield stress for aluminium material is 170N/mm^2. Calculate the force required for extrusion . Assume =0.15 and semi die- angle = 45^0.	8	CO4	L2
	b	with a neat sketch, explain backward extrusion process. Why power involved in backward extrusion is much lesser than direct extrusion.	7	CO4	L2

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15ME563	Sem:	VI	Marks:	5	Time:	90 minutes
Course:	Metal forming						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1		Give the classification of extrusion process and explain hydrostatic extrusion.	7	CO3	L2
2		Briefly explain four extrusion defects with their causes and remedies.	5	CO3	L2
3		It is required to extrude cylindrical aluminium billet of 50mm diameter to 10mm diameter . The length of billet is 75mm and the average yield stress for aluminium material is 170N/mm^2. Calculate the force required for extrusion . Assume μ=0.15 and semi die- angle = 45^0.	5		L2
4		Explain clearly the variables influencing extrusion process.	5	CO4	L2
5		It is required to extrude a cylindrical aluminum billet of 50 mm diameter to 10 mm diameter. The length of the billet is 75 mm and the average tensile yield stress for aluminum material is 170 N/mm2. Calculate the force required for extrusion. Assume , μ= 0.15 and semi-die angle = 45^0.	5	CO4	L2
6		Explain with neat sketches tandem mill and four high rolling mill.	5	CO3	L2
7		Explain optimal cone angle and dead zone formation in drawing with sketches.	5	CO3	L2
8		Explain with neat sketches the wire drawing and rod drawing operations.	5		L2
9		Explain the defects in rolled products with neat sketches.	5	CO4	L2
10		Explain extrusion piping and Chevron cracking defects in extrusion.	5	CO4	L2
11		With neat sketches, explain rubber forming and stretch	5	CO3	L2

		forming.			
12		Explain any four extrusion process variables with sketch	5	CO3	L2
13		Explain combination die and progressive die with neat sketches.	5		L2
14		Explain optimal cone angle and dead zone formation in drawing with sketches.	5	CO4	L2
15		Explain with neat sketches the wire drawing and rod drawing operations.	5	CO4	L2
16		Explain the defects in rolled products with neat sketches.	5	CO3	L2
17		Explain extrusion piping and Chevron cracking defects in extrusion.	5	CO3	L2
18		With neat sketches, explain rubber forming and stretch forming.	5		L2
19		Explain any four extrusion process variables with sketch	5	CO4	L2
20		Explain combination die and progressive die with neat sketches.	5	CO4	L2

D3. TEACHING PLAN - 3

Module – 5

Title:	Powder metallurgy & high energy forming method	Appr Time:	10Hrs
a	***Course Outcomes***	-	**Blooms**
-	student should be able to:	-	**Level**
1	Understand the process of powder metallurgy technique and high energy forming method	CO5	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
41	High Energy Rate Forming Methods	CO5	L2
42	Principles, advantages and applications,	CO5	L2
43	Explosive forming	CO5	L2
44	Electro hydraulic forming,	CO5	L2
45	Electromagnetic forming.	CO5	L2
46	Powder Metallurgy: Basic steps in Powder metallurgy	CO5	L2
47	Brief description of methods of production of metal powders	CO5	L2
48	Conditioning and blending powders.	CO5	L2
49	compaction and sintering application of powder metallurgy components,	CO5	L2
50	advantages and limitations.	CO5	L2
c	**Application Areas**	**CO**	**Level**
1	powder metallurgy is used in filters, cutting tools and die, Machinery Parts , bearing and bushes, magnets	CO5	L2
		CO5	
d	**Review Questions**	CO5	-
1	Discuss the principle of working, advantages and application of i) Explosive forming ii) Electro hydraulic forming	CO5	L2
2	Explain the "atomization" method of powder production in powder metallurgy.	CO5	L2
3	What is "sintering"? Explain its mechanism.	CO5	L2
4	with neat sketches, explain the following forming methods: (i) Explosive forming (ii) Electromagnetic forming.	CO5	L2

5	Discuss with flow chart powder metallurgy process.	CO5	L2
6	Explain the electro-magnetic forming with a sketch. List its advantages, disadvantages and applications.	CO5	L2
7	With a flow chart, explain the basic steps in powder metallurgy process.	CO5	L2
8	Explain the unconfined type or stand off technique of explosive forming with a sketch.	CO5	L2
9	List explosive forming advantages, disadvantages and applications.	CO5	L2
10	Explain atomization with sketch and electrolytic deposition.	CO5	L2
11	Briefly explain continuous roll compaction with sketch.	CO5	L2
e	**Experiences**	-	-
1			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15ME653	Sem:	VI	Marks:	30	Time:	75 minutes
Course:	Metal forming						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Explain the "atomization" method of powder production in powder metallurgy.	8	CO5	L2
	b	What is "sintering"? Explain its mechanism.	7	CO5	L2
		OR		CO5	
2	a	Discuss the principle of working, advantages and application of i) Explosive forming ii) Electro hydraulic forming	8	CO5	L2
	b	Discuss with flow chart powder metallurgy process.	7	CO5	L2
				CO5	
3	a	Discuss the principle and application of electro hydraulic forming.	7	CO5	L2
	b	What are the advantages and disadvantages of high energy rate forming (HERF)?	8	CO5	L2
		OR		CO5	
4	a	Explain the principles of High energy rate forming.	7	CO5	L2
	b	Explain any two methods of production of metal powder with sketches.	8	CO5	L2

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions

Crs Code:	15ME653	Sem:	VI	Marks:	10	Time:	
Course:	Metal forming						

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1		With a flowchart,explain the operations involved in making powder metallurgy parts.	5	CO5	L2
2		Explain the principles of High energy rate forming.	5	CO5	L2
3		With a neat sketch, explain the explosive forming process.	5	CO5	L2
4		Discuss the principle and application of electro hydraulic forming.	5	CO5	L2
5		What are the advantages and disadvantages of high energy rate forming (HERF)?	5	CO5	L2
6		With neat sketches, explain the following forming methods: (i) Explosive forming (ii) Electromagnetic forming.	5	CO5	L2

7		Discuss with flow chart powder metallurgy process.	5	CO5	L2
8		What is HERF? Explain explosive forming, with a neat figure.	5	CO5	L2
9		Explain any two methods of production of metal powder with sketches.	5	CO5	L2
10		With a flow chart, explain in detail the powder metallurgy process.	5	CO5	L2
11		List the application of powder metallurgy components.	5	CO5	L2
12		What is "sintering"? Explain its mechanism.	5	CO5	L2
13		Explain the "atomization" method of powder production in powder metallurgy.	5	CO5	L2
14		With a neat sketch, explain the explosive forming process.	5	CO5	L2
15		Discuss the principle and application of electro hydraulic forming.	5	CO5	L2
16		What are the advantages and disadvantages of high energy rate forming (HERF)?	5	CO5	L2
17		Explain any two methods of production of metal powder with sketches.	5	CO5	L2
18		With a flow chart, explain in detail the powder metallurgy process.	5	CO5	L2
19		List the application of powder metallurgy components.	5	CO5	L2
20		What is "sintering"? Explain its mechanism.	5	CO5	L2

F. EXAM PREPARATION

1. University Model Question Paper

Course:		Metal forming					Month / Year	Dec/2018	
Crs Code:		15ME653	Sem:	VI	Marks:	100	Time:	180 minutes	
-	**Note**	Answer all FIVE full questions. All questions carry equal marks.					**Marks**	**CO**	**Level**
1	a	Explain the classification of metal working processes on the basis of force applied with neat sketches.					10	CO1	L2
	b	Explain Tresca's and von Mises's yield criterions.					6	CO1	L2
		OR							
2	a	Discuss the principle and application of electro hydraulic forming.Obtain the relationship between (a) true strain and engineering strain and (b) true stress and engineering stress.					6	CO2	L2
	b	Explain hot working and cold working. Mention the advantages, disadvantages and effects of hot working.					10	CO2	L2
3	a	Explain the effect of strain rate or deformation velocity on metal forming.					7	CO1	L2
	b	Explain hydrostatic pressure in metal working with a neat sketch.					9	CO1	L2
		OR							
4	a	Explain the effects of temperature, friction and lubrication in metal working.					12	CO2	L2
	b	Briefly explain any four forging defects.					4	CO2	L2
5	a	Explain with neat sketches tandem mill and four high rolling mill.					8	CO3	L2
	b	Explain optimal cone angle and dead zone formation in drawing with sketches.					8	CO3	L2
-		**OR**							
6	a	Explain with neat sketches the wire drawing and rod drawing operations.					8	CO4	L2
	b	Explain the defects in rolled products with neat sketches.					8	CO4	L2
7	a	Explain extrusion piping and Chevron cracking defects in extrusion. Estimate the capacity of the hot extrusion press to extrude I-section of 20					8	CO3	L3

		mm height with 10 mm wide flanges and 2 mm thick, using 30 mm diameter bar stock of an aluminium alloy. Take the yield strength of an aluminium alloy as 150 N/mm 2 . Assume 25% frictional losses and a square die.			
	b	With neat sketches, explain rubber forming and stretch forming.	8	CO3	L2
		OR			
8	a	Explain any four extrusion process variables with sketch.	6	CO4	L2
	b	Explain combination die and progressive die with neat sketches.	10	CO4	L2
9	a	Explain the electro-magnetic forming with a sketch. List its advantages, disadvantages and applications.	8	CO5	L2
	b	With a flow chart, explain the basic steps in powder metallurgy process.	8	CO5	L2
		OR			
10	a	Explain the unconfined type or stand off technique of explosive forming with a sketch. List its advantages, disadvantages and applications.	8	CO5	L2
	b	Explain atomization with sketch and electrolytic deposition.	5	CO5	L2
	c	Briefly explain continuous roll compaction with sketch.	3	CO5	L2

2. SEE Important Questions

Course:	Metal forming					Month / Year	Dec /2018	
Crs Code:	15ME653	Sem:	III	Marks:	100	Time:	180 minutes	
	Note	Answer all FIVE full questions. All questions carry equal marks.				-	-	
Module	Qno.	Important Question				**Marks**	**CO**	**Year**
1	1	Explain the classification of metal working processes on the basis of force applied with neat sketches.				6	CO1	2017
	2	Explain Tresca's and von Mises's yield criterions.				6	CO1	2016
	3	Discuss the principle and application of electro hydraulic forming.Obtain the relationship between (a) true strain and engineering strain and (b) true stress and engineering stress.				8	CO1	2016
	4	Explain hot working and cold working. Mention the advantages, disadvantages and effects of hot working.				8	CO1	2017
2	1	Explain the effect of strain rate or deformation velocity on metal forming.				6	CO2	2015
	2	Explain the concept of friction hill and the factors affecting friction hill in forging.				6	CO2	2017
	3	Explain hydrostatic pressure in metal working with a neat sketch.				8	CO2	2016
	4	Explain the effects of temperature, friction and lubrication in metal working.				6	CO2	2016
	5	Briefly explain any four forging defects.				7	CO2	2017
3	1	Explain with neat sketches tandem mill and four high rolling mill.				8	CO3	2017
	2	Explain optimal cone angle and dead zone formation in drawing with sketches.				6	CO3	2016
	3	Explain with neat sketches the wire drawing and rod drawing operations.				6	CO3	2015
	4	Explain the defects in rolled products with neat sketches.				8	CO3	2015
4	1	With neat sketches, explain rubber forming and stretch forming.				8	CO4	2004
	2	Explain extrusion piping and Chevron cracking defects in extrusion. Estimate the capacity of the hot extrusion press to extrude I-section of 20 mm height with 10 mm wide flanges and 2 mm thick, using 30 mm diameter bar stock of an aluminium alloy. Take the yield strength of an aluminium alloy as 150 N/mm 2 . Assume 25% frictional losses and a square die.				6	CO4	2015
	3	Explain any four extrusion process variables with sketch.				6	CO4	2016
	4	Explain combination die and progressive die with neat sketches.					CO4	
5	1	Explain the electro-magnetic forming with a sketch. List its advantages, disadvantages andapplications.				8	CO5	2016

	2	With a flow chart, explain the basic steps in powder metallurgy process.	6	CO5	2015
	3	Explain atomization with sketch and electrolytic deposition.	6	CO5	2017
	4	Explain the unconfined type or stand off technique of explosive forming with a sketch. List its advantages, disadvantages and applications.	8	CO5	2017