Estd. 1989

SIR C R REDDY COLLEGE OF ENGINEERING

ELURU - 534 007, Eluru Dist., A.P., INDIA

ACCREDITED BY NBA, APPROVED BY ALL INDIA COUNCIL FOR TECHNICIAL EDUCATION, NEW DELHI,
PERMANENTLY AFFILIATED TO JNTUK, KAKINADA

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Ref. No.

Date :.....

2.6.2 Attainment of programme outcomes and course outcomes are evaluated by the institution.

The institution follows a structured process to assess the attainment of program outcomes (POs) and course outcomes (COs), ensuring continuous improvement in teaching and learning.

Step 1: Defining Course Outcomes (COs):

- ✓ COs are outlined in the university syllabus and may be further elaborated on by Department Advisory committee (DAC) by discussions with course coordinators, module coordinators and Program Assessment Committee (PAC).
- ✓ Each CO is assigned a weightage based on its importance to the course.
- ✓ Attainment is measured through continuous internal assessments (assignments, online quizzes and descriptive tests) and the semester-end exam, focusing on direct assessment methods.

Step 2 & 3: Direct and Indirect Assessment:

- ✓ **Direct assessment:**Direct assessment involves evaluating student performance in both internal and external examinations, with the final course grade based on a weighted average of these assessments.
- ✓ **Indirect assessment:**Before final exams, students' complete course-end surveys to provide feedback on their learning experience. These surveys, rated on a five-point scale, are used to indirectly assess student learning and are then converted to a three-point scale for analysis.
- ✓ By taking the weighted average of internal, external and course end survey the final CO attainment is calculated.

Step 4 & 5: Mapping COs to POs and PSOs:

- ✓ Attained COs are mapped to POs and PSOs with assigned weightage to determine their contribution to overall program goals.
- ✓ COs of specific subjects are mapped to relevant POs on a scale of 3, 2, and 1. Attainment for each PO is calculated by averaging the attainment of all COs related to that PO.
- ✓ Similar calculation will be done for all the PO's. The PO attainment for a batch of students will be calculated by taking the sum of all attainments for a particular PO and dividing by the number of courses mapped to the same PO.

Indirect Assessment Tools :

Questions relevant to the POs/graduate attributes and PSOs are given to the students at the end of the program and are rated on a five-point scale. These questions will be asked to gather student opinion and observations about the programme. The exit survey attainment will be calculated accordingly. PO attainment for a batch is then calculated by giving 80% weightage to direct attainment and 20% weightage to exit survey results. Similar calculations are performed for PSO attainment.

- ✓ This mapping is visualized through graphs for analysis.

Step 6: Assessment Integration:

- ✓ The CO-PO/PSO mapping and assessment process are incorporated into assignments and lab work.

Step 7: Qualitative Analysis and Action:

- ✓ Course experts analyze the attainment of COs and their contribution to POs/PSOs.
- ✓ Based on this analysis, they identify areas for improvement and develop action plans to address any gaps, including incorporating additional content or teaching methods.

Step 8: Continuous Improvement:

- ✓ If CO attainment falls below satisfactory levels, teaching methods are revised to enhance student learning.
- ✓ Attainment at satisfactory levels indicates effective teaching methods.

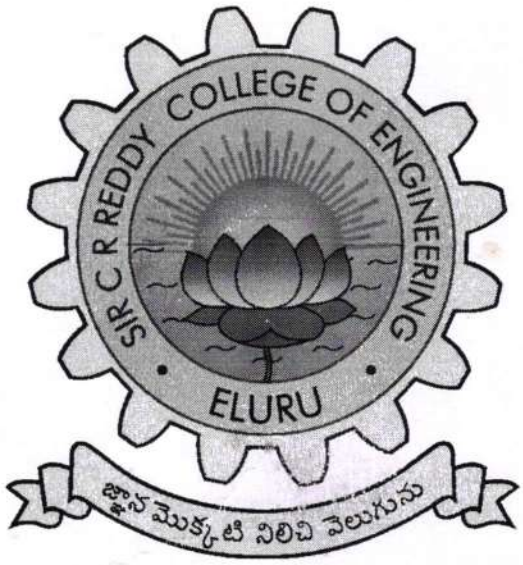
IQAC Co-ordinator

SIR C R REDDY COLLEGE OF ENGINEERING ELURU 534 007

Principal

Principal
Sir C R Reddy College of Engineering
ELURU - 534 007

COURSE FILE



DEPARTMENT OF MECHANICAL ENGINEERING

ACADEMIC YEAR: 2019-20

PROGRAMME: B.TECH

TITLE OF THE COURSE	: METROLOGY	BATCH	: 2019-20
COURSE CODE	: R1632031	SECTION	: A
YEAR & SEMESTER	: III/IV & II	NO OF STUDENTS	: 68
COURSE CATEGORY	: CORE		

FACULTY DETAILS	
NAME OF THE FACULTY	: CHANDRARAO CHANDU
DESIGNATION	: ASSISTANT PROFESSOR
DEPARTMENT	**: MECHANICAL ENGINEERING**

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DEPARTMENT OF MECHANICAL ENGINEERING

COURSE FILE INDEX

S. No.	Description	Status
1.	Vision & Mission	√
2.	PEOs and POs	√
3.	Course Description	√
4.	Academic calendar	√
5.	Class Time table	√
6.	Course Data Sheet (Syllabus, COs, CO-PO Mapping, Justification)	√
7.	Student List	
8.	Topics beyond Syllabus	√
9.	Lesson Plan	√
10.	Pedagogical Teaching methodologies	√
11.	Daily Delivery report (From Attendance Register)	√
12.	Unit wise Lecture notes	√
13.	Tutorial Sheets	√
14.	Unit wise-Question Bank	√
15.	List of slow learners and remedial class work conducted	√
16.	Quality Analysis of internal exam question paper and Assignments	√
17.	Internal Exam question paper with answer key & Scheme of valuation	√
18.	University question papers	√
19.	Attainment of COs & POs (From FCARs)	√
20.	Course End Survey	√
21.	Sample Scripts	√
22.	University End Exam Result	√

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DEPARTMENT OF MECHANICAL ENGINEERING

VISION & MISSION OF THE INSTITUTE

VISION:

"To emerge as a premier institution in the field of technical education and research in the state and as a home for holistic development of the students and contribute to the advancement of society and the region."

MISSION:

M1: To provide high quality technical education through a creative balance of academic and industry oriented learning.

M2: To create an inspiring environment of scholarship and research.

M3: To instill high levels of academic and professional discipline.

M4: To establish standards that inculcate ethical and moral values that contributes to growth in career and development of society in general.

VISION & MISSION OF THE DEPARTMENT

VISION:

"To be a center of excellence in the field of Mechanical Engineering in this region where the best of teaching, learning and research synergize with a broader sense of social responsibility".

MISSION:

M1: Creating an environment conducive for high quality teaching and learning

M2: Enabling the students to meet the challenges of the industry through research oriented education and entrepreneurial activities.

M3: Inculcating ethical values and responsibility towards environment and society with leadership qualities

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DEPARTMENT OF MECHANICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES

PEO1 Excel in professional career through the knowledge in Mathematics, Science and Engineering principles

PEO2 Solve real time mechanical engineering problems using knowledge, skills and modern tools that are economically feasible, as required for the industry

PEO3 Exhibit professionalism, ethical attitude, team work, multidisciplinary approach and engage in research and lifelong learning in the mechanical engineering field

PEO4 Develop the skill of methodical approach for decision making and designing of mechanical systems

PEO5 Create awareness towards social, environmental and energy related issues and emphasize on effective communication skills and professionalism

PROGRAM OUTCOMES

1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
4. **Conduct investigations of complex problems** using research based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
5. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an under- standing of the limitations.

6. **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7. **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
11. **Life-long Learning:** Recognize the need for and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.
12. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Program Specific Outcomes:

PSO1: Demonstrate proficiency in design and analysis of automobile and aviation parts using advanced software tools.

PSO2: Acquire skills to automate manufacturing processes.

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DEPARTMENT OF MECHANICAL ENGINEERING

COURSE DESCRIPTION

In today's world of high-technology products, the most important requirements of dimensional and other accuracy controls are becoming very stringent as a very important aspect in achieving quality and reliability in the service of any product in dimensional control. Unless the manufactured parts are accurately measured, assurance of quality cannot be given. In this context, the course deals with the basic principles of dimensional measuring instruments and precision measurement techniques. The first 2 modules deal with the basic concepts of metrology and measurement standards. Then, linear, angular, geometrical shape metrology along with interferometry techniques and various types of comparators are explained in the subsequent modules. Concepts of limits, fits and tolerances and surface finish measurement, screw thread and gear measurements are also presented in detail

TARGET:

a) Percentage Pass - 90 %

b) Percentage I class - 60 %.

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DEPARTMENT OF MECHANICAL ENGINEERING

ACADEMIC CALENDER

Grams: "TECHNOLOGY"
Email: dapjntuk@gmail.com

Phone: 0884-2300991
Mobile: +9963993504

Directorate of Academic & Planning
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA-533003, Andhra Pradesh, INDIA
(Established by AP Government Act No. 30 of 2008)

Lr. No. JNTUK/DAP/AC/B. Tech/III Year/2019-20 *Date: 30-05-2019*

Dr. A. Mallikarjuna Prasad
M.E, Ph.D.,
Director, Academic Planning

To
All the Principals of Affiliated Colleges,
JNTUK, Kakinada

ACADEMIC CALENDAR FOR B.TECH III YEAR (2017 BATCH)

I SEMESTER			
Description	**From**	**To**	**Weeks**
Commencement of Class Work	**10.06.2019**		
I Unit of Instructions	10.06.2019	03.08.2019	8W
I Mid Examinations	05.08.2019	10.08.2019	1W
II Unit of Instructions	12.08.2019	05.10.2019	8W
II Mid Examinations	07.10.2019	12.10.2019	1W
Preparation & Practicals	14.10.2019	19.10.2019	1W
End Examinations	21.10.2019	02.11.2019	2W
Commencement of II Semester Class Work	**18.11.2019**		
II SEMESTER			
I Unit of Instructions	**18.11.2019**	11.01.2020	8W
I Mid Examinations	13.01.2020	23.01.2020	1W
II Unit of Instructions	24.01.2020	21.03.2020	8W
II Mid Examinations	23.03.2020	28-03-2020	1W
Preparation	30.03.2020	04.04.2020	1W
End Examinations	06.04.2020	18.04.2020	2W
Commence of IV Year Class Work	**08.06.2020**		

A.M.prasad
Director Academic Planning

Copy to the Secretary to the Hon'ble Vice Chancellor, JNTUK.
Copy to PA to the Rector, JNTUK.
Copy to PA to the Registrar, JNTUK.
Copy to PA to the Director of Evaluation, JNTUK.

K.V.R. 03/6/19
Examination-in-charge
Sir C.R.R. College of Engineering

Principal
SIR C.R.R. COLLEGE OF ENGINEERING
ELURU - 534 007.

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TIME TABLE

CHCR 19

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DEPARTMENT OF MECHANICAL ENGINEERING

TIME TABLE (2019 - 2020) - (II SEMESTER)

TEA BREAK : 10.40 A.M - 11.00 A.M ---------- LUNCH BREAK: 12.40 P.M - 01.40 P.M

Revised on 03.12.2019

(SECTION A) III/IV B.E W.e.f. 18.11.2019 Room: LH - 19

	1	2	3	4	5	6	7	8
	9:00 - 9:50	9:50 - 10:40	11:00 - 11:50	11:50 - 12:40	01:40 - 2:30	2:30 - 3:20	3:20 - 4:10	4.10 - 5.00
MON	ICS	CFD lab			M&I Lab/H T Lab			COUNSELLING
TUE	HT	R&AC	HT	Metrology	M&I Lab/H T Lab			LIBRARY/Reme
WED	IR	Metrology	IR	R&AC	PEHV	PEHV	PEHV	SPORTS/Remedi
THU	R&AC	R&AC(T)&HT(T)	HT	ICS	SKILL DEVELOPMENT(ASR)			LIBRARY/Reme
FRI	R&AC	ICS	Metrology	HT	SKILL DEVELOPMENT(CHRK)			SPORTS/Remedi
SAT	IR	Metrology	IR	ICS				

Metrology	CHCR	Industrial Robotics	EVR
Instrumentation & Control Systems	VNK	Heat Transfer Lab	PSBC / PCS
Refrigeration & Air-conditioning	PSBC	Metrology & Instrumentation Lab	CHCR/ASR
Heat Transfer	PCS	Computational Fluid Dynamics Lab	CHRK / MNVA
SKILL DEVELOPMENT: 3D DASSAULT SYSTEMS		Professional Ethics & Human Values	ASG

H.O.D

PRINCIPAL

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DEPARTMENT OF MECHANICAL ENGINEERING

COURSE DATA SHEET

COURSE NAME: Metrology	**COURSE CODE: C32031**	**REGULATION:** R16
PROGRAM / YEAR / SEMESTER: B.Tech./III/ II	**CREDITS:** 03	
COURSE TYPE: Inter Disciplinary		
COURSE AREA/DOMAIN: MANUFACTURING	**CONTACT HOURS:**4 per week.	
CORRESPONDING LAB NAME, CODE (IF ANY): Metrology & Instrumentation Lab		
PRE-REQUISITE (IF ANY): Basics of ManufacturingEngineering, Metric and SI units of physical quantities, Statistics and Trigonometry		

SYLLABUS

Course objectives:

The students will learn

1. Inspection of engineering parts with various precision instruments
2. Design of part, tolerances and fits
3. Principles of measuring instruments and gauges and their uses
4. Evaluation and inspection of surface roughness
5. Inspection of spur gear and thread elements
6. Machine tool testing to evaluate machine tool quality

UNIT-I

SYSTEMS OF LIMITS AND FITS: Introduction, nominal size, tolerance, limits, deviations, fits -Unilateral and bilateral tolerance system, hole and shaft basis systems-interchangeability, determistic& statistical tolerances, selective assembly. International standard system of tolerances, selection of limits and tolerances for correct functioning.

UNIT-II

LINEAR MEASUREMENT: Length standards, end standards, slip gauges- calibration of the slip gauges, dial indicators, micrometers.

MEASUREMENT OF ANGLES AND TAPERS:

Different methods – bevel protractor, angle slip gauges- angle dekkor- spirit levels- sine bar- sine table, rollersand spheres used to measure angles and tapers.

LIMIT GAUGES:

Taylor's principle – design of go and no go gauges; plug, ring, snap, gap, taper, profile and position gauges.

UNIT-III

OPTICAL MEASURING INSTRUMENTS: Tools maker's microscope and uses - autocollimators, opticalprojector, optical flats and their uses.

INTERFEROMETRY:
Interference of light, Michelson's interferometer, NPL flatness interferometer, and NPL gauge interferometer.

UNIT-IV
SURFACE ROUGHNESS MEASUREMENT: Differences between surface roughness and surface waviness –Numerical assessment of surface finish-CLA, Rt., R.M.S. Rz, R10 values, Method of measurement of surfacefinish – Profilograph, Talysurf, ISI symbols for indication of surface finish.
COMPARATORS: Types - mechanical, optical , electrical and electronic, pneumatic comparators and theiruses.

UNIT – V
GEAR MEASUREMENT: Nomenclature of gear tooth, tooth thickness measurement with gear tooth vernier &flange micro meter, pitch measurement, total composite error and tooth to tooth composite errors, rolling geartester, involute profile checking.
SCREW THREAD MEASUREMENT: Elements of measurement – errors in screw threads- concept of virtualeffective diameter, measurement of effective diameter, angle of thread and thread pitch, and profile threadgauges.

UNIT – VI
FLATNESS MEASUREMENT:
Measurement of flatness of surfaces- instruments used- straight edges- surface plates – autocollimator.
MACHINE TOOL ALIGNMENT TESTS: Principles of machine tool alignment testing on lathe, drilling andmilling machines.

Text Books:
1. Dimensional Metrology/Connie Dotson/Cengage Learning
2. Engineering Metrology / R.K.Jain / Khanna Publishers

References:
1. Engineering Metrology / Mahajan / Dhanpat Rai Publishers
2. Engineering Metrology / I.C.Gupta / Dhanpat Rai Publishers
3. Precision Engineering in Manufacturing / R.L.Murthy / New Age
4. Engineering Metrology and Measurements / NV Raghavendra, L Krishna murthy/ Oxford publishers.
5. Engineering Metrology / KL Narayana/Scitech publishers

Course outcomes:
Students will be able to design tolerances and fits for selected product quality. They can choose appropriatemethod and instruments for inspection of various gear elements and thread elements.
They can understand thestandards of length, angles, they can understand the evaluation of surface finish and measure the parts withvarious comparators. The quality of the machine tool with alignment test can also be evaluated by them.

WEB SOURCE REFERENCES:

W1	https://nptel.ac.in/courses/112/104/112104250/
W2	https://youtube.com/playlist?list=PLbMVogVj5nJSZiwuh_tp50dKry8mCxzKA
W3	www.nikonmetrology.com
W4	www.mitutoyo.com

TOPIC BEYOND THE SYLLABUS:

S. NO.	GAP	PROPOSED ACTIONS	PROPOSED RESOURCE
1	Modern instruments Usage in industry	computer aided inspection,3D Metrology	Self-delivery

INSTRUCTIONAL METHODOLOGIES:

x	CHALK & TALK	x	ASSIGNMENT	x	WEB RESOURCES	x	LCD/SMART BOARDS
x	SEMINARS		ADD-ON COURSES		ANY OTHER (SPECIFY)		

PEDAGOGICAL INITIATIVES:

x	USE OF ICT	x	MODEL DEMONSTRATION		QUIZ	x	REAL WORLD EXAMPLES
	COLLABORATIVE LEARNING		POSTER PRESENTATION				
			ANY OTHER				

CO-PO ASSESSMENT METHODOLOGIES-DIRECT

x	INTERNAL EXAMINATION	x	ASSIGNMENTS	x	ONLINE QUIZ		MINI/MAJOR PROJECT
	INTERNALLY DEVELOPED EXAMS		LABORATORY TESTS		ANY OTHER (SPECIFY)		

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DEPARTMENT OF MECHANICAL ENGINEERING

CO-PO ASSESSMENT METHODOLOGIES-INDIRECT

x	COURSE END SURVEY		CO-CURRICULAR ACTIVITIES		EXTRA CURRICULAR ACTIVITIES

COURSE OUTCOMES (COs):

CO NO.	DESCRIPTION
C32031.1	Design tolerances and fits for selected product quality
C32031.2	Use instruments for linear and angular measurement parameters, surface roughness and geometric features of parts.
C32031.3	Evaluate the surface finish by different techniques and measure the parts with various comparators
C32031.4	Apply methods of measurement for various physical quantities for gears and screw threads
C32031.5	Evaluate the quality of different machine tools by using alignment tests.

POs & PSOs REFERENCE:

PO1	Engineering Knowledge	**PO6**	Engineer & Society	**PO11**	Project Mgt. & Finance
PO2	Problem Analysis	**PO7**	Environment & Sustainability	**PO12**	Life Long Learning
PO3	Design & Development	**PO8**	Ethics	**PSO1**	Design Skill
PO4	Investigations	**PO9**	Individual & Team Work	**PSO2**	Manufacturing Skill
PO5	Modern Tools	**PO10**	Communication Skills		

CO-PO MAPPING (HIGH:3; MEDIUM:2; LOW:1):

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C32031.1	2	-	-	-	-	-	2	-	-	-	-	2	-	3
C32031.2	2	-	-	-	-	-	2	-	-	-	-	2	-	3
C32031.3	2	-	-	-	-	-	2	-	-	-	-	2	-	3
C32031.4	3	-	-	-	-	-	2	-	-	-	-	3	-	3
C32031.5	3						2					3		3

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JUSTIFICATION FOR CO-PO MAPPING:

CO	PO	Relevance
C322.1	PO1	Apply the knowledge of mathematics, science, engineering fundamentals to design tolerances and fits for selected product quality.
	PO7	Understand the impact of the professional engineering solutions in society and environmental contexts while Designing tolerances and fits for selected product quality
	PO12	Design tolerances and fits for selected product qualityaccording to technological changes with continuous learning.
	PSO2	Design tolerances and fits for selected product quality with the aid of computer.
C322.2	PO1	Apply the knowledge of mathematics, science, engineering for linear and angular measurement of parameters such as surface roughness and geometric features of parts using instruments.
	PO7	Understand the impact of linear, angular,surface roughness and geometric features measurements in professional engineering solutionsin society and environmental contexts.
	PO12	Recognize the need to engage in independent and life-long learning in the broadest context of technological changes in the instruments.
	PSO2	Acquire skills to automate measuring instruments.
C322.3	PO1	Apply the knowledge of mathematics, science, engineering fundamentals evaluate the surface finish by different techniques and measure the parts with various comparators.
	PO7	Demonstrate the knowledge of Evaluation of surface finish by different techniques and measure the parts with various comparators.
	PO12	Recognize the need for evaluation of the surface finish by different techniques and measure the parts with various comparators and engage in independent and life-long learning in the broadest context of technological change.
	PSO2	Acquire skills to automate surface finish measuring instruments and comparators in manufacturing.
C322.4	PO1	Apply the knowledge of mathematics, science, engineering fundamentals in various methods of measurement for various physical quantities for gears and screw threads.
	PO7	Understand the impact of application various methods of measurement for various physical quantities in professional engineering solutions in society and environmental contexts.
	PO12	Recognize the need to engage in life-long learning of methods of measurement for various physical quantities for gears and screw threads in the broadest context of technological change.
	PSO2	Acquire skills to automate various methods of measurement in manufacturing.

C322.5	PO1	Apply the knowledge of mathematics, science and engineering fundamentals to evaluate the quality of different machine tools by using alignment tests.
	PO7	Understand the impact of evaluation of the quality of different machine tools using alignment tests for professional engineering solutions in society and environmental contexts.
	PO12	Recognize the need to engage in independent and life-long learning in the broadest context of technological changes of machine tools measurement.
	PSO2	Acquire skills to automate alignment tests for measuring the quality in manufacturing.

	K. Lalit Narayan	K. Lalit Narayan	
COURSE HANDLER	COURSE CO-ORDINATOR	MODULE CO-ORDINATOR	HOD

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DEPARTMENT OF MECHANICAL ENGINEERING

STUDENT LIST

SIR C.R.R.COLLEGE OF ENGINEERING, ELURU

DEPARTMENT OF MECHANICAL ENGINEERING

2017 - 18 Admitted & 2020 - 21 out - going batch

III/IV B.Tech - II Semester Rolls List - SECTION - A

A. Y. 2019 - 20

S.No	Regd.No	Names
1	17B81A0302	AGATAMUDI NARENDRA KUMAR
2	17B81A0309	ANNEPU APPALA NAIDU
3	17B81A0312	BENDI LOKESWARA RAO
4	17B81A0313	BUDUMURI YUGANDHAR
5	17B81A0315	CHANDRAKANTH NALLAGANGULA
6	17B81A0316	CHAPPATI MADHU
7	17B81A0319	CHINNAM HARSHA VARDHAN
8	17B81A0321	DAGGUBATI SAI RAJESH
9	17B81A0325	DATLA HARSHA VARDHAN VARMA
10	17B81A0326	DHANALAKOTA NAGA VIJAYESWAR
11	17B81A0330	GADE SURYA LAXMI KUMAR
12	17B81A0332	GANTYADA SOMESWARA RAO
13	17B81A0334	GIDIJALA RAVI KUMAR
14	17B81A0335	GONDU HEMA SUNDARA RAO
15	17B81A0337	INDUROTHU DURGA PRASAD
16	17B81A0339	KAMSU SRINIVASA RAO
17	17B81A0340	KANAPARTHI GOKUL SAI
18	17B81A0343	KOLLI SRAVAN KUMAR
19	17B81A0345	KOMMANTI GOVINDU
20	17B81A0346	KOTA LOKESH
21	17B81A0348	MAMILLA PREETHAM
22	17B81A0350	MANNEM PURUSHOTHAM SAI
23	17B81A0351	MARRAPU YUVA KIRAN
24	17B81A0353	MUTYALA V S N PAVAN KUMAR
25	17B81A0354	N BHASKARA SAI ABHINASH
26	17B81A0357	PAIDI RAMBABU
27	17B81A0359	PAPOLU SRINADH
28	17B81A0360	PARASURAPU LOKESH
29	17B81A0362	PAYASAM SAI SRIKANTH
30	17B81A0363	PENKE SAI RATHNAKAR
31	17B81A0364	PERAM AJAY BABU
32	17B81A0367	POLAGANI SATISH KUMAR
33	17B81A0368	PULAVARTHI SANDEEP
34	17B81A0371	PYDI RAJA SEKHAR

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35	17B81A0373	RAMA SATYA SAI PRASAD APPARI
36	17B81A0375	RAVIPALLI VENKATESH
37	17B81A0377	SAGI NAGA SAI
38	17B81A0380	SHAIK NAYEEM
39	17B81A0382	SINGAMPALLI SAI KRISHNA
40	17B81A0383	SUNKARI BHARATH REDDY
41	17B81A0384	SUVVADA MAHESH
42	17B81A0386	TATIPAKA NIKHIL
43	17B81A0387	TENTU UPENDRA NAIDU
44	17B81A0388	THANIGADAPA SUSHMA LATHA
45	17B81A0391	UPPALA BHARGAV SAI BALAJI
46	17B81A0392	VABBALAREDDI RAMA SIVA VENKATA SAI KUMAR
47	17B81A0393	VALUKULA RAMYA SRI LEKHA
48	17B81A0395	VEERAVALLI TEJA SRI
49	17B81A03A2	BHIMAVARAPU SUKUMARI
50	17B81A03A4	RAJA KHARJURA KUSHAL SAI
51	17B81A03A5	VADDELLI THRIMALESH PHANI
52	18B85A0304	BARNIKANA VENKATESH
53	18B85A0306	CHALAPAKA BHANU PRASAD
54	18B85A0307	CHELLURI NOOKARAJU
55	18B85A0308	GALLA JAGADEESWARA RAO
56	18B85A0311	INJARAPU BHARGAV
57	18B85A0312	KADAGALA ARUN DURGA PRASAD
58	18B85A0313	KETHINEDI NAGA HANUMA KUMAR
59	18B85A0314	KOKKIRAPATI NAVEEN
60	18B85A0315	KOLIKIPAMULA RAJESH
61	18B85A0317	KOPPIREDDY HARI KRISHNA DATTATREYA
62	18B85A0319	MARPU RAVI
63	18B85A0323	NEKARAKANTI VENKATESH
64	18B85A0324	NUKALA PAVAN KUMAR
65	18B85A0327	PATCHA DURGA PRASAD
66	18B85A0332	THOTA HEMA NAGA MALLESWARA RAO
67	18B85A0333	UPPALAPATI SAI SEETHARAM
68	18B85A0334	VANDRINKI RAMU

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TOPICS BEYOND SYLLABUS

Academic Year: 2019-20

Name of the Program: B.Tech. in ME		
Course: Metrology		**Course Code: C32031**
Year: III	**Semester: II**	**Section: A**
Name of the Faculty: Ch. Chandra Rao		**Designation:** Asst. Professor

Computer Aided Inspection

Computer Aided Inspection (CAI) is a new technology that enables one to develop a comparison of a physical part to a 3D CAD model. This process is faster, more complete, and more accurate than using a Coordinate Measuring Machine (CMM) or other more traditional methods. An automatic inspection method and apparatus using structured light and machine vision camera is used to inspect an object in conjunction with the geometric model of the object. Camera images of the object are analyzed by computer to produce the location of points on the object's surfaces in three dimensions. Point-cloud data is taken from a laser scanner or other 3-D scanning device. During a setup phase before object inspection, the points are analyzed with respect to the geometric model of the object. The software provides a graphical comparison of the manufactured part compared to the CAD model. Many points are eliminated to reduce data-taking and analysis time to a minimum and prevent extraneous reflections from producing errors. When similar objects are subsequently inspected, points from each surface of interest are spatially averaged to give high accuracy measurements of object dimensions. The inspection device uses several multiplexed sensors, each composed of a camera and a structured light source, to measure all sides of the object in a single pass.

Computer controlled inspection equipment

Coordinate Measuring Machine (CMM) is a 3-dimensional measuring device that uses a contact probe to detect the surface of the object. The probe is generally a highly sensitive pressure sensing device that is triggered by any contact with a surface. The linear distances moved along the 3 axes are recorded, thus providing the x, y and z coordinates of the point. CMMs are classified as either vertical or horizontal, according to the orientation of the probe with respect to the measuring table.

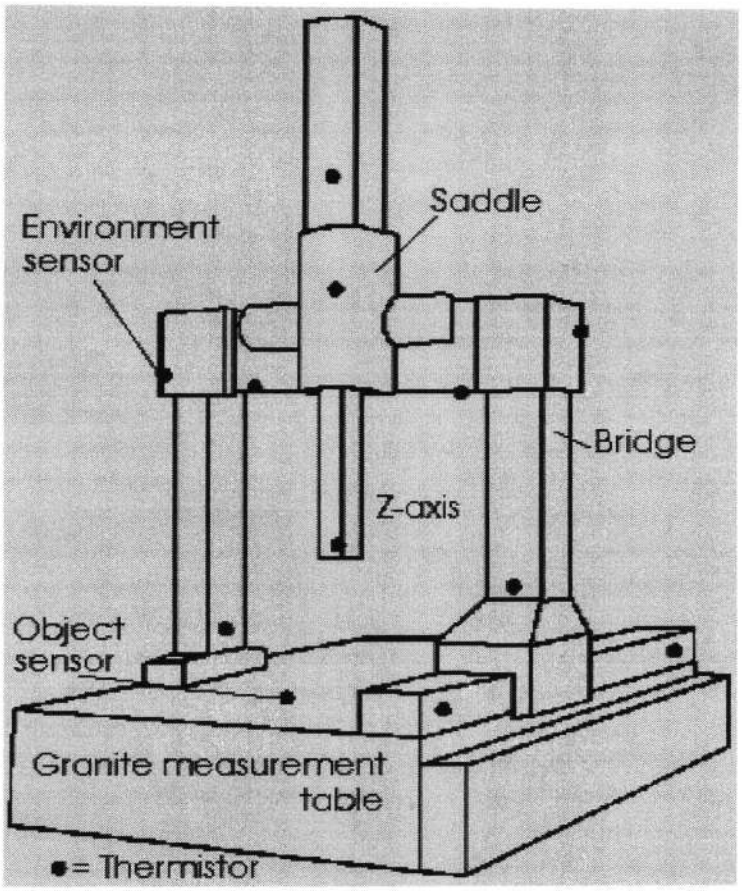

Fig. Coordinate Measuring Machine (CMM)

Reference:

1. Computer aided inspection: design of customer-oriented benchmark for noncontact 3D scanner evaluation. DOI 10.1007/s00170-008-1562-x

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LESSON PLAN

Academic Year: 2019-20

Semester: VI	
Name of the Program: B. Tech	**Year: 2019-20Section: A**
Course/Subject: METROLOGY	**Course Code: R1632031**
Name of the Faculty: Chandra Rao.Ch	**Department: ME**
Designation: Assistant Professor	

S. No.	No. of Hrs.	Topic(s) planned	CO	Teaching Methodology
1	1	**UNIT-I:**Systemsof limitsand fits-Introduction.	CO1	Chalk & Talk
2	2	Normal size, tolerance limits, deviations.	CO1	Chalk & Talk, PPTPresentation
3	3	Allowance, fitsand their types.	CO1	Chalk & Talk, PPTPresentation
4	4	Unilateral and bilateral tolerance system.	CO1	Chalk & Talk, PPTPresentation
5	5	Hole basissystem.	CO1	Chalk & Talk, PPTPresentation
6	6	Shaft basissystem.	CO1	Chalk & Talk, PPTPresentation
7	7	Interchangeability and selective assembly.	CO1	Chalk & Talk, PPTPresentation
8	8	Indian standard institution system.	CO1	Chalk & Talk, PPTPresentation
9	9	British standardsystem-	CO1	Chalk & Talk, PPTPresentation
10	10	Internationalstandard system for screwed work.	CO1	Chalk & Talk, PPTPresentation
11	11	**UNIT-II:** Linear Measurement-Length standard, Line and end standard.	CO2	PPTPresentation
12	12	Slip gauges, dial indicator	CO2	Chalk & Talk, PPTPresentation
13	13	Vernier calipers, micrometers.	CO2	Chalk & Talk, PPTPresentation
14	14	Measurement of anglesand tapes-Bevel protractor.	CO2	Chalk & Talk, PPTPresentation
15	15	Angle slip gaugesspirit levels.	CO2	Chalk & Talk, PPTPresentation
16	16	Sine bar, sine plate.	CO2	Chalk & Talk, PPTPresentation

17	17	Rollersand spheresused to determine the tapers.	CO2	Chalk & Talk, PPTPresentation
18	18	Taylor's principle, design of go and no-go gauges.	CO2	Chalk & Talk, PPTPresentation
19	19	Plug ring, snap Gauges	CO2	Chalk & Talk, PPTPresentation
20	20	Gap,taper,Gauges	CO2	Chalk & Talk, PPTPresentation
21	21	Profile and position gauges	CO2	Chalk & Talk, PPTPresentation
22	22	**UNIT-III:**Optical measuring instruments, Toolmaker's microscope.	CO2	Chalk & Talk, PPTPresentation
23	23	Toolmaker's microscope uses	CO2	Chalk & Talk, PPTPresentation
24	24	Autocollimators	CO2	Chalk & Talk, PPTPresentation
25	25	Optical projector	CO2	Chalk & Talk, PPTPresentation
26	26	Optical flats and their uses	CO2	Chalk & Talk, PPTPresentation
27	27	**Interferometry:**Interference of light,	CO2	PPTPresentation
28	28	Michelson's interferometer	CO2	Chalk & Talk, PPTPresentation
29	29	NPL flatness interferometer	CO2	Chalk & Talk, PPTPresentation
30	30	NPL gauge interferometer	CO2	Chalk & Talk, PPTPresentation
31	31	**UNIT-IV:SURFACEROUGHNESS MEASUREMENT:** Difference between surface roughness and surface waviness	CO3	PPTPresentation
32	32	Numerical assessment of surface finish- CLA, RMS values,	CO3	Chalk & Talk, PPTPresentation
33	33	Rz, R10 values.	CO3	Chalk & Talk, PPTPresentation
34	34	Methodsofsurface finishmeasurement.	CO3	Chalk & Talk, PPTPresentation
35	35	Profilograph.	CO3	Chalk & Talk, PPTPresentation
36	36	Talysurf.	CO3	Chalk & Talk, PPTPresentation
37	37	ISIsymbolsforindicationofsurfacefinish.	CO3	Chalk & Talk, PPTPresentation
38	38	**Comparators:** IntroductionofComparators-Types Mechanical comparators.	CO3	Chalk & Talk, PPTPresentation

39	39	Optical comparators, Electricalcomparators.	CO3	Chalk & Talk, PPTPresentation
40	40	Electroniccomparators, Pneumaticcomparators.	CO3	Chalk & Talk, PPTPresentation
41	41	Applicationsofcomparatorsinmass production.	CO3	Chalk & Talk, PPTPresentation
42	42	**UNIT-V GEAR MEASUREMENT:** Nomenclature of gear tooth	CO4	Chalk & Talk, PPTPresentation
43	43	Measurement of tooth thickness with gear tooth vernier& flange micrometer	CO4	Chalk & Talk, PPTPresentation
44	44	Pitch measurement	CO4	Chalk & Talk, PPTPresentation
45	45	Total composite error and tooth to tooth composite errors	CO4	Chalk & Talk, PPTPresentation
46	46	Rolling gear tester, involute profile checking	CO4	Chalk & Talk, PPTPresentation
47	47	**SCREWTHREADMEASUREMENT:** Elements of measurement- Errorsinscrewthreads.	CO4	Chalk & Talk, PPTPresentation
48	48	Concept of virtual effectivediameter	CO4	Chalk & Talk, PPTPresentation
49	49	Measurementofeffectivediameters.	CO4	Chalk & Talk, PPTPresentation
50	50	Angle ofthreadandthreadpitch.	CO4	Chalk & Talk, PPTPresentation
51	51	Profilethreadgauges.	CO4	Chalk & Talk, PPTPresentation
52	52	Measuring instrumentsforscrewthread	CO4	Chalk & Talk, PPTPresentation
53	53	**UNIT-VI FLATNESS MEASUREMENT:** Measurement of flatness of surfaces	CO5	Chalk & Talk, PPTPresentation
54	54	Instruments used	CO5	PPTPresentation
55	55	Straightedges	CO5	Chalk & Talk, PPTPresentation
56	56	surface plates.	CO5	Chalk & Talk, PPTPresentation
57	57	Auto collimator	CO5	Chalk & Talk, PPTPresentation
58	58	**MACHINE TOOL ALIGNMENT TESTS:**Principles of machine tool alignment testing on lathe	CO5	Chalk & Talk, PPTPresentation
59	59	Alignment testing on drilling machine	CO5	Chalk & Talk, PPTPresentation
60	60	Alignment testing on milling machine	CO5	PPTPresentation

Signature of faculty

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Pedagogical Teaching Methodologies used for teaching this course

PEDAGOGICAL INITIATIVES:

X	Use of ICT		Model Demonstration		Quiz	X	Real World Examples
	Collaborative Learning		Poster Presentation		Any Other		

Teaching Real World Examples of metrology with the help of ICT

The application of metrology in manufacturing.

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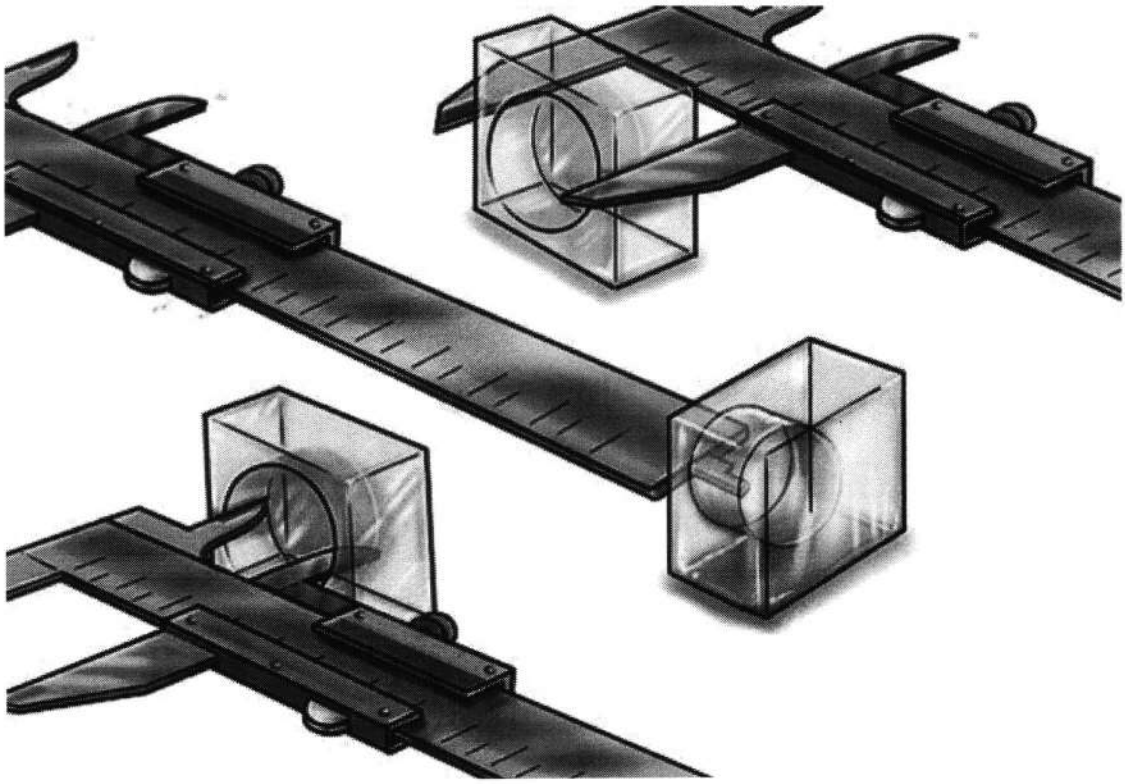
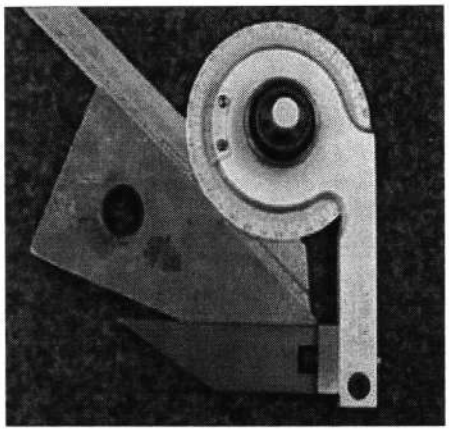
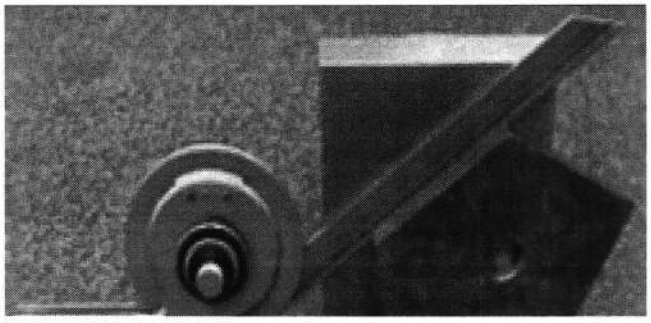




Measuring AcuteAngles



Measuring Obtuse Angles

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DAILY DELIVERY REPORT

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SYLLABUS COVERAGE REPORT

Syllabus Coverage Report for the Academic year ..... 2019-20 .....

Course : III /IV B.E./B.Tech. : Mech-A Subject : Metrology (R16320311)

No. of the Staff Member : Chandrakar Chandu No.of Classess Conducted : 57

Date	Time	Topics Covered	Remarks
19/11/19	11.50-12.40	Introduction to Metrology	
20/11/19	9.50-10.40	Nominal size, tolerance, limits	
23/11/19	9.50-10.40	Types of Metrology - objectives of Met.	
26/11/19	11.50-12.40	Methods of Measurements	
29/11/19	11.00-11.50	Unilateral and bilateral systems	
30/11/19	9.50-10.40	Hole and shaft basis selections, system interchangability	
02/12/19	11.50-12.40	International standard system of tolerances	
04/12/19	9.50-10.40	Problems on Fits and tolerances	
06/12/19	11.00-11.50	Linear Measurement - Introduction	
07/12/19	9.50-10.40	Introduction to slip gauges	
10/12/19	11.50-12.40	Slip gauges - calibration	
11/12/19	9.50-10.40	Dial Indicators, Micrometers	
13/12/19	11.50-12.40	Measurement of angles and Tapers	
14/12/19	9.50-10.40	Dial Indicators - Types	
17/12/19	11.50-12.40	Different Methods of Angle and Taper Measurement	
18/12/19	9.50-10.40	Angle Slip Gauges, Spirit levels, angle dekkor	
20/12/19	11.50-12.40	Sine bar - sine table, Rollers and spheres to det. Tapers	
21/12/19	9.50-10.40	Limit Gauges, Taylor's Principle, Design of Gauges	
28/12/19	9.50-10.40	Optical Measuring instruments - Introduction	
03/01/20	11.50-12.40	Tool Maker's Microscope and its uses	
04/01/20	9.50-10.40	Auto collimator, optic Projector	
07/01/20	11.50-12.40	Optical Flats and their uses	
10/01/20	11.50-12.40	Interferometry - Introduction	
11/01/20	9.50-10.40	Optical Projector	
20/01/20	11.50-12.40	Interferometer of Light Michelson - Mid-P	
28/01/20	11.50-12.40	Surface Roughness Measurement - Introduction	

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SYLLABUS COVERAGE REPORT

Syllabus Coverage Report for the Academic year ..... 2019-20 .....

Course : I/II/III/IV B.E./B.Tech. : Mech-A Subject : Metrology (R1631031)

No. of the Staff Member : Chandrarao Ch No.of Classess Conducted : 57

Date	Time	Topics Covered	Remarks
01/02/20	9.50-10.40	Inspection of surface Roughness	
04/02/20	11.50-12.40	Surface Roughness and surface waviness	
07/02/20	11.00-11.50	Inspection of surface roughness	
08/02/20	9.50-10.40	Numerical Assessment of surface roughness	
11/02/20	11.50-12.40	Methods of Measuring surface roughness	
13/2/20	9.50-10.40	Rz value, Ra value	
14/02/20	11.50-12.40	Methods of Measurement of surface (profilograph, talysurf, Finish)	
18/2/20	9.50-10.40	BIS symbols for indication of surface finish	
18/02/20	11.50-12.40	Comparators Introduction	
22/02/20	9.50-10.40	Mechanical and optical type comp.	
26/2/20	9.50-10.40	Electrical and Electronic, pneumatic	
28/2/20	11.50-12.40	Nomenclature of Gear tooth	
29/2/20	9.50-10.40	Tooth thickness measurement (vernier) gear tooth	
03/3/20	11.50-12.40	Pitch Measurement, total and tooth to tooth (composite errors)	
04/3/20	9.50-10.40	Rolling gear tester and involute profile (checking)	
06/3/20	10.00-11.50	Screw thread Measurement	
07/3/20	11.50-12.40	Errors in screw threads.	
06/3/20	11.50-12.40	Virtual effective diameter	
07/3/20	9.50-10.40	Measurement of effective diameter	
11/3/20	9.50-10.40	Thread pitch and profile thread gauges	
11/3/20	11.50-12.40	Measurement of flatness of surfaces	
14/3/20	9.50-10.40	Straight Edges	
17/3/20	11.50-12.40	Surface plates, auto collimator	
18/3/20	9.50-10.40	Machine tool alignment tests - Introduction	
20/3/20	11.50-12.40	Principles of Machine tool alignment testing (on lathe)	
21/3/20	9.50-10.40	Alignment tests on drilling machine	

Ch. Chandrarao

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SYLLABUS COVERAGE REPORT

Syllabus Coverage Report for the Academic year ..... 2019-20 .....

Course : III /IV B.E./B.Tech. : Mech-A Subject : Metrology (R1632031)

Name of the Staff Member : Ch. ChandraRao No.of Classess Conducted : 54

Date	Time	Topics Covered	Remarks
24/1/20	11.50-12.40	Alignment tests on milling Machine	
25/1/20	9.50-10.40	Review of Previous Paper questions in 4 units	
27/1/20	11.50-12.40	Review of Previous Paper questions in III & IV units	
28/1/20	9.50-10.40	Review of Previous Paper questions in V unit	

Signature of the Staff Member

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LECTURE NOTES

https://drive.google.com/drive/folders/1WwmyjgeNtNO9xESKHEkBHsx1eCOCC327?usp=sharing

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TUTORIAL SHEET -1

Academic Year: 2019-20

Name of the Program: B.Tech. in ME		
Course: Metrology		**Course Code: R1632031**
Year: III	**Semester: II**	**Section: A**
Name of the Faculty: Ch. Chandra Rao		**Designation:** Asst. Professor

Unit-I

1. Distinguish between repeatability and reproducibility.
2. Illustrate the objectives of metrology
3. Distinguish between Line standard and End standard.
4. Differentiate between precision and accuracy.
5. Give any four methods of measurement.

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TUTORIAL SHEET-2

Academic Year: 2019-20

Name of the Program: B.Tech. in ME		
Course: Metrology		**Course Code: R1632031**
Year: III	**Semester: II**	**Section: A**
Name of the Faculty: Ch. Chandra Rao		**Designation:** Asst. Professor

Unit-II

1. What are the construction requirements of a good sine bar?
2. (a)Explain the classification of linear measuring instruments.(5)

   (b) Explain the vernier height gauge with neat sketch. (8)
3. Explain the following with neat sketches. (13)

   a. Differential screw micrometer and (b) Thread micrometer
4. What is a slip gauge? Write notes on its classifications. (5)
5. A vernier scale consists of 25 divisions on 12 mm spacing and the main scale has 24 divisions on12 mm. What is the least count?

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TUTORIAL SHEET-3

Academic Year: 2019-20

Name of the Program: B.Tech. in ME		
Course: Metrology		**Course Code: R1632031**
Year: III	**Semester: II**	**Section: A**
Name of the Faculty: Ch. Chandra Rao		**Designation:** Asst. Professor

Unit-III

1. Name the different types of interferometers.
2. Point out the application of Laser Interferometer.

4.(a) With a neat sketch describe the working of AC laser interferometer.

(b) Explain the usage of laser interferometer in straightness testing.

5. Describe the working principle of a dual frequency laser interferometer with a neat sketch
6. (a) Discuss the working principle of the NPL Flatness interferometer.

(b) What is meant by alignment test on machine tools? Give its importance.

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TUTORIAL SHEET-4

Academic Year: 2019-20

Name of the Program: B.Tech. in ME		
Course: Metrology		**Course Code: R1632031**
Year: III	**Semester: II**	**Section: A**
Name of the Faculty: Ch. Chandra Rao		**Designation:** Asst. Professor

Unit-IV

1. Differentiate between surface roughness and waviness.
2. Discussthefollowingtermsinconnectionwithsurfacefinishmeasurement:
   (i)Waviness, (ii)Lay,
   (iii)Roughness, (iv) Centre line profile.
3. How surface texture is related to tolerances on a surface dimension? Discuss which measure of surface roughness is now recommended by ISO?
4. What is a comparator? How they are classified? State the various uses of comparators.
5. Mention the basic requirements of a comparator.

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DEPARTMENT OF MECHANICAL ENGINEERING

TUTORIAL SHEET-5

Academic Year: 2019-20

Name of the Program: B.Tech. in ME		
Course: Metrology		**Course Code: R1632031**
Year: III	**Semester: II**	**Section: A**
Name of the Faculty: Ch. Chandra Rao		**Designation:** Asst. Professor

Unit-V

1. Brief about Parkinson's gear tester.
2. With a neat sketch, explain about checking involute shape of gear.
3. Explain about total composite error and tooth to tooth composite errors.
4. Define error in measurement. Explain the types of errors in screw thread and gear measurement.
5. Compare two wire and three wire methods of measuring the effective diameter of a screw.

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DEPARTMENT OF MECHANICAL ENGINEERING

TUTORIAL SHEET-6

Academic Year: 2019-20

Name of the Program: B.Tech. in ME		
Course: Metrology		**Course Code: R1632031**
Year: III	**Semester: II**	**Section: A**
Name of the Faculty: Ch. Chandra Rao		**Designation:** Asst. Professor

Unit-VI

1. Describe with a neat sketch the principle of working of an auto-collimator.
2. Explain alignment tests for lathe machine.
3. Explain alignment tests for milling machine.
4. Brieflyexplainthevariousalignmentteststhatcanbeperformedonashaper.
5. Explain alignment tests for drilling machine.

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DEPARTMENT OF MECHANICAL ENGINEERING

UNITWISE METROLOGY QUESTION BANK

1. Distinguish between repeatability and reproducibility.
2. What is the difference between allowance and tolerance?
3. Define primary measurement. Give an example.
4. List the Seismic instruments.
5. What are the factors affecting the measuring system?
6. Define legal metrology.
7. Illustrate the objectives of metrology
8. Summarize the basic components of a measuring system.
9. Distinguish between Line standard and End standard.
10. Explain the term Sensitivity of an instrument.
11. Differentiate between precision and accuracy.
12. Define the term reliability and Traceability.
13. Give any four methods of measurement.
14. Define Span.
15. Give classification of measuring instruments.
16. Define parasitic and illegitimate error.
17. Point out the sources of error.
18. Explain the role of N.P.L.
19. What is the difference between correction and correction factor?
20. Distinguish between static and random error.
21. What are the various elements of metrology? With examples,
22. Explain how these elements influence the accuracy of measurements. (13)
23. Explain the need of standards of measurements in the modern

24. industrial system and describe the term traceability in connection with standards. (13)

25. Explain the classification of various measuring methods. (13)

26. Give the structure of generalized measurements system and explain in detail. (13)

27. (a) Illustrate the desirable characteristics of precision measuring instruments (8)

(b) Discuss about the fundamental and derived units in details. (5)

28. Describe briefly about,

(a) Uncertainty (b) Reporting results (13)

29. (b) Give an example for the Zero order system.

(a) With suitable example explain the difference between precision and accuracy.

30. Distinguish between and give appropriate examples in each case, (13)

(a) Repeatability and Reproducibility

(b) Systematic and random error

(c) Static and dynamic Response

31. Obtain the expression for the step response of a second order system. (13)

32. Describe briefly about,

(a) sensitivity and readability (8) (b) Calibration. (5)

33. What is the need of calibration? Explain the classifications of various standards. (13)

34. Explain the various errors in measurements. (13)

35. What are thevarious possible sources of errors in measurements? Explain in detail.

36. Briefly explain the various types of input signals. (13)

37. Briefly explain the significance of Metrology and Measurements in industrial application.

38. Explain various errors observed in measuring any industrial product.

39. Enumerate the desirable characteristics of precision measuring instruments.
40. Explain the steps to be followed in the measurement process.
41. Point out any four precautions to be taken while using gauge blocks.
42. Why rocking procedure is followed when measuring with a dial bore gauge?
43. A 100 mm sine bar was used to measure the tapper angle of the specimen and the gauge block was 5.055mm. Calculate the tapper angle.
44. What is difference between gauging and measurements?
45. Summarize the various types of linear measuring instruments.
46. What is the use of Feeler gauges?
47. List out any four angular measuring instruments used in metrology.
48. A vernier scale consists of 25 divisions on 12 mm spacing and the main scale has 24 divisions on12 mm. What is the least count?
49. List different types of fits.
50. Define sine center.
51. What are the construction requirements of a good sine bar?
52. Explain Taylor principle in gauge design.
53. Illustrate briefly about wringing of slip gauges.
54. Name any four instruments used measuring internal diameters in components.
55. Explain the concept of interchangeability.
56. Define clinometers.
57. Describe the usage of autocollimator.
58. Explain an angle alignment telescope.
59. List out the need of angle gauges.
60. Explain the concept of selective assembly.

61. Describe briefly about,

    (a) Write notes on interchangeability. (5)

    (b) Sketch the construction and working of solex pneumatic comparator. (8)

62. i) Explain with suitable sketches measurements of straightness using Auto collimator. (8)

    ii) Describe the GO and NOGO gauge design procedure with a sketch (5)

63. Calculate the limits for a hole shaft pair designated 25 H8/d9.Show graphically the deposition of tolerance zones with reference to the zero line. The lower deviation for a H type hole is zero. 25 mm lies in the diameter range 18mm to 30 mm. Standard tolerance foe IT 8 is 25i and IT 9 is 40i, where "i" is the standard tolerance unit in microns and is given as $i(\mu m)=0.45\ 3\sqrt{D}+0.001D$, (D is in mm). The upper deviation for d shaft is -16D0.44. (13)

64. (a)Explain the classification of linear measuring instruments. (5)

    (b) Explain the vernier height gauge with neat sketch. (8)

65. Explain the following with neat sketches. (13)

    (a) Differential screw micrometer and (b) Thread micrometer

66. What is a slip gauge? Write notes on its classifications. (5)

67. How slip gauges are manufactured? Write notes on slip gauge accessories and its calibration.

68. (a) What is a comparator? Explain any two types of Mechanical comparator. (8)

    (b) Describe the working principle, advantages and disadvantages of Optical comparator(5)

69. Explain the construction and working principle autocollimator with neat a diagram and its application of an (13)

70. Describe with the help of a neat, any two bevel protractors. (13)
71. Define straightness. Describe any one method of measuring straightness of the surface.(13)
72. Explain working principle of sine bar and why sine bars are not suitable for measuring angles above 450? (13)
73. Describe working principle of angle Dekkor with the neat sketch and also write its application.
74. Explain the following methods, (13)
    (a) Measurements of angle by using rollers,
    (b) Checking the angle of taper plug gauge using roller,
    (c) Measuring of included angle of an internal dovetail.
75. Describe brief note on laser as a means of alignment checking. (13)
76. Calculate the tolerances, fundamental deviations and limits of sizes for the shaft designated as 40H8/f7.Standard tolerance for IT 7 is 16i and IT 8is 25i. Where 'i' is the standard tolerance unit. Upper deviation for 'f' shaft is -5.5D0.41,40 mm lies in the diameter range 30-50 mm.
77. Design a workshop type progressive type Go-Not-GO plug gauge suitable for 25H7, with following information:
78. i. 25 mm lies in the diameter step of 18-30 mm ii. $i = 0.453\sqrt{D}+0.001D$
    iii. IT7 = 16i
79. Explain the significance of Linear and angular measurements.
80. How laser is used in measurement? Explain the basic principle involved in any one application.
81. On what factor the accuracy of laser interferometer mainly depends?

82. Why is laser preferred in engineering metrology?

83. Name the different types of interferometers.

84. Point out the application of Laser Interferometry.

85. Give the advantages of laser interferometer.

86. Why monochromatic light used in an interferometer instead of white light?

87. Mention the various geometric checks made in machine tools.

88. Differentiate straightness and flatness.

89. Discuss the applications of computer aided inspection.

90. Define axial slip of a machine tool.

91. Explain briefly about wavelength.

92. List any four possible causes of errors in CMM.

93. Point out the applications of CMM in machine tool metrology

94. What is meant by "Qualifying the tip" in CMMs?

95. Illustrate briefly about alignment test on machine tools.

96. Give the disadvantages of CMM.

97. Briefly describe the term Machine vision.

98. What is CNC CMM?

99. Point out the advantages of machine vision system?

100. Write any four application of artificial vision system in

101. manufacturing industries.

102. (a) With a neat sketch explain the dimensional measurements using laser gauge.

(b) Summarize how to use laser interferometer to predict machine tool accuracies.

103. (a) With a neat sketch describe the working of AC laser interferometer. (8)

(b) Explain the usage of laser interferometer in straightness testing. (5)

104. Describe the working principle of a dual frequency laser interferometer with a neat sketch (13)

105. (a) Discuss the working principle of the NPL Flatness interferometer. (8)

(b) What is meant by alignment test on machine tools? Give its importance.

106. Explain the construction and working of various types of CMM (13)

107. (a) List out the applications of CMM (8)

(b) Point out the advantages and disadvantages of CMM. (5)

108. (a) Discuss about the various causes of errors in CMM (5)

109. List out the methods of operating and controlling a CMM (8)

110. (a) Briefly explain the important features available in CMM software. (8)

(b) With neat diagram explain the working principle of tough trigger probes. (5)

111. (a) Define machine vision. Name four types of machine vision systems. (8)

(b) Describe in details of functions of machine vision system (5)

112. (a) Illustrate the features of flexible inspection system. (8)

(b)Explain the various steps of machine vision system in metrology (5)

113. (a) Explain the applications of machine vision system. (8)

(b)Discuss the advantages and disadvantages of Machine vision system. (5)

UNIT-IV

SURFACE ROUGHNESS MEASUREMENT AND COMPARATORS

SAQ'S

1. What is the importance of surface roughness? Mention the geometrical characteristics of asurface. [4M] Nov.-15
2. Indicate how various surface roughness specifications are placed relative to the symbol.[4M] Nov-15
3. What are the factors affecting surface roughness?

4. Enumerate various methods of measuring surface finish. Oct/Nov. -16
5. Differentiate between direct and indirect method of measurement of surface roughness.
6. What is a comparator? Classify the different types of comparators. Oct/Nov. -16
7. What are the advantages and limitations of Johanson's Mikrokrator? Oct/Nov. -17
8. Difference and distinguish between the mechanical and optical comparators. May/June-14
9. The heights of peaks and valleys of 20 successive points on a surface are 35, 25,40, 22, 37, 19, 41, 21, 42, 18, 42, 24, 44, 25, 40, 18, 40, 18, 39, and 21 microns respectively, measured over a length 20mm.Determine CLA and RMS values of roughness surface. [6M] Nov.-15
10. In the measurement of surface roughness, heights of 20 successive peaks and troughs were measured from a datum and were 35, 25, 40, 22, 35, 18, 42, 25, 35, 22, 36, 18, 42, 22, 32, 21, 37, 18, 35 and 20 microns. If these measurements were obtained over a length of 20 mm, determinethe CLA and RMS value of the rough surface. Oct/Nov -16
11. Explain the following terms with reference to surface roughness measurement:
    (i) CLA value (ii) Maximum peak to valley height (iii) Sampling length. [3M] NOV-15, Set-3
12. Explain how CLA index number is determined. [3M] NOV-15, Set-4
13. Explain the following
    (i) Touch inspection
    (ii) Visual inspection
    (iii) Scratch inspection and
    (iv) Microscopic inspection OCT/NOV -16, Set-2
14. What is a comparator? How does it differ from measuring instruments? OCT/NOV -17, Set-3

ESSAY QUESTIONS

15. Explain briefly the different parameters used in measurement of surface texture. May/June-14, Set-2
16. Differentiate between primary and secondary texture. OCT/NOV -17, Set-1, OCT/NOV -16, Set-1

    OR

    Differentiate between surface roughness and waviness. Nov-15, Set-1

    OR

    Write the difference between surface roughness and surface waviness. May/June-14, Set-1
17. Discuss the following terms in connection with surface finish measurement: (i) Waviness, (ii) Lay,

(iii) Roughness, (iv) Centre line profile. [4M] Nov-15, Set-4

18. Describe various methods of numerical assessment of surface finish. [4M] Nov-15, Set-1
19. State the possible causes of each of the various types of irregularities found in surface texture. Show how surface having the same numerical assessment may have the different properties and textures. OCT/NOV -17, Set-1
20. How surface texture is related to tolerances on a surface dimension? Discuss which measure of surface roughness is now recommended by ISO? OCT/NOV -17, Set-3
21. Describe Centre Line Average method of finding surface roughness value. How do you determine mean line? Describe with a graph. Explain the terms Traversing Length and True Profile length of a surface texture. OCT/NOV -17, Set-2
22. Enumerate the different modes of defining surface texture. OCT/NOV -17, Set-4

    OR

    Explain different methods of measuring surface finish.
23. Describe the principle and working of Tracer type profilograph with the help of a neat sketch. OCT/NOV -17, Set-4

    OR

    Describe the working principle of profilograph. Nov-15, Set-2
24. Explain with a neat sketch, the principle and working of Talysurf surface roughness tester for themeasurement of surface finish. OCT/NOV -16, Set-2

    OR

    Explain the neat sketch, the working of Taylor Hobson Talysurf. OCT/NOV -16, Set-3

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    R

    Describe with a neat sketch the construction, principle and operation of Talysurf. NOV -15, Set-1OR

    Explain With a neat sketch explain the working of Taylor Hobson Talysurf instrument for surfaceroughness measurement. April/May -13, Set-3
25. Explain profilometer for the measurement of surface finish. OCT/NOV -16, Set-4

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    R

    With a neat sketch explain about profilometer. April/May -13, Set-2
26. Brief about Tomlinson surface recorder. OCT/NOV -17, Set-2
27. With a neat sketch explain the working of double microscope for evaluating surface roughness.April/May -13, Set-4
28. Describe in detail about reasons for controlling surface texture and order of geometricirregularities. April/May -13, Set-1
29. What are various orders of geometrical irregularities on surfaces? How these

are classified? [4M]Nov-15,Set-3

30. What is a comparator? How they are classified? State the various uses of comparators. April/May-13, Set-4
31. Mention the basic requirements of a comparator. [3M] Nov-15, Set-2

OR

List out various characteristics of comparator.

32. Explain the system of displacement amplification used in mechanical comparator.
33. With the help of neat sketch explain the working principle of a reed type mechanicalcomparator. [8M] Nov-15,Set-2
34. Explain with a neat sketch the principle and working of sigma comparator. Oct/Nov.-16, Set-2,4
35. Why damping is essential in mechanical comparators? How it is achieved in sigma comparator?
36. Explain the differential comparator with neat sketch.
37. Describe in detail about Johansson Mikrokrator with a neat sketch. April/May -13, Set-1
38. Describe in detail about Zeiss optotest comparator with neat sketch and list out their advantagesalso. April/May -13, Set-3
39. State the principle on which the optical comparators are based. Oct/Nov.-16, Set-4

OR

40. Describe the principle of mechanical comparator with neat sketch. May/June-14, Set-3
41. Compare among measuring instrument, gauge and comparator.
42. Describe and sketch two types of comparators with special reference to the means of magnifyingthe movement of the stylus. Oct/Nov.-17, Set-4
43. What are the requirements of a good comparator? Explain with the help of a neat sketch how thesefeatures are achievable in the "sigma comparator". Oct/Nov.-17, Set-1
44. Differentiate between a comparator and measuring machine. Discuss the fundamentalrequirements of a comparator. Oct/Nov.-17, Set-2
45. With a neat sketch, explain the working principle of electrical comparators. April/May -13, Set-3
46. Explain with a neat sketch any one of the electrical comparator. Oct/Nov.-16, Set-3

OR

47. With the help of a line diagram explain the working of LVDT.
48. What are the advantages, uses and disadvantages of electrical comparators? [6M] Nov-15, Set-3
49. Describe the working principle of an electronic comparator. [5M] Nov-15,Set-4

50. Explain how a pneumatic comparator works and briefly enumerate the advantages of differentpneumatic comparators. Oct/Nov-16, Set-3
51. Explain with a neat sketch construction and working of the solex pneumatic comparator. Oct/Nov-16, Set-1

OR

52. Describe the working principle of a solex pneumatic comparator. Nov-15, Set-4
53. Explain the specific advantages and limitations of pneumatic comparator over other comparatorsused in practice. Oct/Nov-17, Set-3

OR

54. What are the advantages and disadvantages of pneumatic comparators? May/June-14, Set-4

UNIT-V

GEARS AND SCREW THREAD MEASUREMENTS

SAQ's

1. Explain base circle, pitch circle, pitch circle diameter with the help of figure. April/May-12
2. Explain how various elements of screw thread are measured. [3M] Nov.-15, Set1OR
3. Enumerate various screw thread parameters for metrological measurement. Also enlist instrumentscorresponding to their measurements. [4M] Nov.-15,Set2
4. Describe the tooth thickness measurement with flange micro meter. [4M] Nov.-15, Set4
5. Differentiate between simple effective diameter and virtual effective diameter of an externalscrew. [4M] Nov.-15,Set3
6. Explain the method of checking the thread form and angle. [4M] Nov.-15, Set4
7. What is the "Best size" wire?
8. Define the term constant chord. Calculate the chord length and its distance below the tooth tip fora gear of module 3 and 20 pressure angle. April-10,set2
9. Calculate chord length and its distance below the tooth tip for a gear of module 4 mm and pressureangle 20^0.Oct/Nov-17, Set-1

ESSAY QUESTIOPNS

10. Explain about gear tooth terminology. Oct/Nov-16, Set-4

OR

With neat sketch, discuss the gear tooth nomenclature and indicate the different parts. May/June-14, Set-3

11. What are the different instruments used in gear tooth metrology? Explain any two. May/June-14, Set-3

12. Explain with a neat sketch, how the chordal thickness is measured by using gear tooth verniercalliper. Oct/Nov.-17, Set-1

OR

Illustrate gear tooth vernier calliper with suitable examples. Oct/Nov.-17, Set-3

OR

Describe any one method to measure the thickness of a spur gear. May/June-14, Set-4

13. Describe a gear tooth vernier caliper and show how it is used for gears? Oct/Nov.-16, Set-3

OR

14. Describe a gear tooth Vernier and indicate how the tooth thickness is checked with thisinstrument. [5M] Nov.-15, Set-1
15. Describe with the help of a neat sketch the working principle of Gear tooth vernier caliper. [6M]Nov.-15, Set-2
16. Enumerate the elements of gears which are checked for accuracy. April/May-13, Set-1
17. Describe in detail various types of errors occurring in gears. Oct/Nov.-16, Set-1, April/May-13,Set-4
18. Explain any two methods of measuring gear pitch? Oct/Nov.-16, Set-2
19. Explain the test plug method for checking pitch diameter and tooth spacing. April/May-12, Set-3
20. Brief about Parkinson's gear tester. Oct/Nov.-17, Set-4

OR

Describe Parkinson gear tester. Oct/Nov.-17, Set-2

OR

With neat sketch explain the working of a Rolling gear tester. [6M] Nov.-15, Set-3

21. Explain about automatic gear measuring machine with neat sketch. April/May-13, Set-3
22. With a neat sketch, explain about checking involute shape of gear. Oct/Nov.-16, Set-4, Aril/May-13, Set-3

OR

Explain the method to check involute profile of a screw thread. [5M] Nov.-15, Set-4

23. Explain about total composite error and tooth to tooth composite errors. [4M] Nov.-15, Set-3
24. Explain the principle of operation of a rolling gear tester. State the errors in a spur gear that can bedetected by the rolling gear tester. Oct/Nov.-16, Set-1
25. Explain about bench micrometer for measuring major diameter of threads. April/May-13, Set-1

26. Write short notes on "errors in screw threads". Oct/Nov.-16, Set-2

    OR

    Explain the different errors in screw threads in engineering metrology. May/June-14, Set-3
27. Define error in measurement. Explain the types of errors in screw thread and gear measurement.Oct/Nov.-17, Set-4
28. Describe in brief how the errors in elements of thread affect the working of the threaded elements.
29. Describe the following terms in screw threads: (i) Major diameter, (ii) Minor diameter, (iii) Toothhickness and (iv) Pitch [4M] Nov.-15, Set-2
30. Discuss on angle of thread, thread pitch, and profile thread gauges. [6M] Nov.-15, Set-3
31. Explain about thread micrometer for measuring effective diameter with neat sketch. April/May-13, Set-2
32. Explain the (i) Two wire method (ii) Three wire method with neat sketches. May/June-14, Set-3
33. Compare two wire and three wire methods of measuring the effective diameter of a screw.
34. Explain how effective diameter of an internal thread can be measured?
35. What are the two corrections applied in the measurement of effective diameter by the method ofwires?
36. Derive expression for best size wire diameter.
    Oct/Nov.-17, Set-4OR
    What is 'best size of wire' for effective diameter measurement? Derive a relationship for the bestsize wire in terms of its effective diameter. [6M] Nov.-15, Set-2
37. Calculate the effective diameter and best wire diameter for M22x2.5 srew plug by using floatingcarriage micrometer for which reading were taken as:
    Diameter of standard cylinder = 20 mm
    Micrometer reading over standard cylinder with two wire = 15.9334 mm
    Micrometer reading over plug screw gauge with two wire = 15.2245 mm.
    Oct/Nov.-17, Set-3
38. Briefly explain the measuring of effective diameter by using 3- wire method. Oct/Nov.-16, Set-2
39. With a neat sketch illustrate how the effective diameter of a screw thread may be checked usingthe three-wire method. [6M] Nov.-15, Set-1
40. Define "effective diameter ". Explain the 3-wire method of finding the effective diameter of screwthreads. Oct/Nov.-17, Set-1
41. Explain 2-wire method pf measuring effective diameter of a screw thread. Oct/Nov.-16, Set-3OR
42. With a neat sketch explain how the simple effective diameter of a screw

thread may be checkedusing the two-wire method. [7M] Nov.-15, Set-4

Describe briefly the method of measuring thread angle of a screw thread. Oct/Nov.-16, Set-4Elucidate measurement method of thread angle by two ball method.

43. Describe a pitch measuring machine with a neat sketch. April/May-13, Set-3
44. Briefly describe with necessary sketches how the following elements of screw thread aremeasured. Oct/Nov.-16, Set-1
45. Describe the pitch measurement of internal screw threads by various methods. [5M] Nov.-15, Set-1
46. Describe with a neat sketch the measurement of pitch of internal and external screw threads usinga pitch measuring machine. Oct/Nov.-17, Set-2

UNIT-VI

FLATNESS MEASUREMENT AND MACHINE TOOL ALIGNMENT TESTS

SAQ's

1. List out different methods of measuring flatness. Oct/Nov.-17, Set-4
2. Distinguish between straightness and flatness.
3. Write short notes on "surface plates". Oct./Nov. -16, Set-4
4. What are the uses of surface plates? Oct/Nov.-17, Set-3
5. Write short notes on "straight edges". Oct/Nov.-16, Set-3
6. Describe with a neat sketch the principle of working of an auto-collimator. Oct/Nov.-16, Set-2
7. What are the advantages of using granite for precision measurements?
8. Enlist the instruments and equipment essential for performing alignment tests. [4M] Nov.-15, Set-3
9. State Abbe principle of alignment. Explain it with suitable example. Oct/Nov.-17, Set-1
10. Name some alignment tests performed on lathe machine. Oct/Nov.-17, Set-2
11. What is the effect upon the work if tail stock center line is parallel to but slightly above the headstock spindle axis? [4M] Nov.-15, Set-4

ESSAY QUESTIONS

FLATNESS MEASUREMENT TESTS

12. Explain the following methods of measuring flatness.
    (i) Flatness comparators
    (ii) Liquid method Oct/Nov.-16, Set-2

13. Mention the types of straight edges.
14. With a sketch, explain the construction of autocollimator. What are its applications? Oct/Nov.-17,Set-1

    OR

    Explain the principle of autocollimator for flatness measurement with neat sketch. Oct/Nov.-17,Set-2

    OR

    What is a principle of autocollimator? Discuss on applications of autocollimator? [6M] Nov.-15,Set-4
15. Explicate the utility of straight edge and surface plate in laboratories. [6M] Nov.-15, Set-3
16. Describe procedures for straightness, flatness & circularity measurement. Oct/Nov.-17, Set-1
17. Explain how a precision level can be used to determine the flatness and straightness of machinebeds. [6M] Nov.-15, Set-1
18. List out and briefly explain any two flatness measurement instruments. Oct/Nov.-17, Set-3

    OR

    What is flatness? What are the various methods of checking flatness of surfaces? [9M] Nov.-15,Set-2
19. Describe with a neat sketch the principle of working of an auto-collimator. Explain how flatnessof the surface is determined with help of an auto-collimator. Oct/Nov.-16, Set-1
20. List out and briefly explain any two instruments used for straightness measurement. Oct/Nov.-17,Set-4
21. Discuss with suitable sketches, the method for testing for straightness by using spirit level andauto collimator. [8M] Nov.-15, Set-1

MACHINE TOOL ALIGNMENT TESTS

22. Explain various instruments required for performing the alignment tests on machine tools.
23. Distinguish between alignment tests and performance tests on machine tools. [4M] Nov.-15, Set-1

    OR

    Differentiate geometric and practical tests on machine tools. [6M] Nov.-15, Set-4
24. With neat sketches describe the following tests on the lathe. Oct/Nov.-16, Set-1
    (i) Spindle centre run- out
    (ii) Spindle taper bore run – out
    (iii) Cros slide run - out
    (iv)Chuck run - out

25. What is meant by alignment tests on machine tools? Why they are necessary? Briefly describe anyfive alignment tests that can be performed on a Lathe Machine. Oct/Nov.-16, Set-4
26. Explain alignment tests for lathe machine. Oct/Nov.-17, Set-1

OR

27. Explain in detail with suitable sketches about various alignment tests performed on a lathe. [10M]Nov.-15, Set-1
28. Explain alignment tests for milling machine. Oct/Nov.-17, Set-3

OR

Briefly describe the various alignment tests that can be performed on a milling machine.Oct/Nov.-16, Set-3

OR

Explain with suitable sketches the various alignment tests performed on milling machine.[10M] Nov.-15, Set-3

29. Briefly explain the various alignment tests that can be performed on a shaper. April/ May-13, Set-2
30. Explain alignment tests for drilling machine. Oct/Nov.-17, Set-2

OR

Briefly describe the various alignment tests that can be performed on a drilling machine.Oct/Nov.-16, Set-2

OR

31. Describe how you would perform alignment tests on drilling machine. [7M] Nov.-15, Set-2

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(Approved by AICTE, New Delhi & Permanently affiliated to JNTU, KAKINADA)

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DEPARTMENT OF MECHANICAL ENGINEERING

LIST OF SLOW LEARNERS

Name of the Program: B.Tech **Year: III Semester: II** **Section: A**

Course/Subject: Metrology **Course Code: C321**

Name of the Faculty: Ch. Chandra Rao **Department: Mechanical**

(This sheet shows identification of slow learners based on I Internal Exam marks)

S. No.	Roll No.	MID-I MARKS	03/02/2020	10/02/2020
1	17B81A0354	11	P	P
2	17B81A03A4	5	P	P

Ch. Chandra Rao

Signature of faculty

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DEPARTMENT OF MECHANICAL ENGINEERING

Remedial Class: I **Date:03/02/2020** **Time: 5.00pm-6:40pm**

Topic:SYSTMS OF LIMITS AND FITS

Introduction: -

Metrology is derived from a Greek word which means "measurement". It is the science of measurement and measurement is the language of science. But, for engineering purposes it has limited to the measurement of length, angles and other quantities that can be expressed in linear and angular terms. It is concerned with the methods execution and estimation of accuracy of measurements.

Metrology plays a vital role in the field of engineering for the designing and manufacturing of various engineering products. It is used for measuring the size, shape, etc. The products obtained should be in the limits of the specification with dimensional accuracy. In order to improve the process of manufacturing, it is required to develop the means of measurement. Every type of quantity measured must be followed by the units, which gives the correct meaning to the quantity measured.

Significance of Metrology:

a. Metrology is very helpful in the scientific investigation of our dynamic world.

b. lt plays a critical role in the fields of chemistry, nanotechnology, etc.

c. Metrology provides an infrastructure not only for physical and natural sciences but also exceeds to comprise environment, medicine, agriculture and food.

d. Various higher-level studies demonstrate the impact of measurement to the society.

LIMITS: -

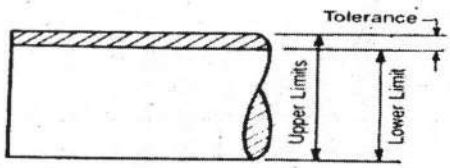
Limits can be defined as the permissible variation in dimension that is permitted to account for variability. Manufacturing process is a combination of three elements man, materials and machine. A change in any one or all of these will result in changes in sizes of manufactured parts. Usually in mass production, large number of components are to be made by different operators on different machines. So, it is impossible to make all components with exact dimensions.

The difference in dimensions vary from machine to machine, operator to operator and quality of the components. The dimension of the manufactured part can thus only be made to lie between two limits, maximum and minimum. The maximum limit is the maximum size permitted for the component whereas the minimum limit is the minimum size permitted for the component.

TOLERANCE: -

The permissible variation in size or dimension is called tolerance. Thus, the word tolerance indicates that a worker is not expected to produce the part to the exact size, but a definite small size error is permitted. The difference between the upper limit (high. limit) and the lower limit of a dimension represents the margin for variation in' workmanship, and is called a 'tolerance Zone'.

Tolerance can also be defined as the amount by which the job is allowed to go away from accuracy and perfectness without causing any functional trouble, when assembled with its mating part and put into actual service.



Tolerance

For example, a shaft of 25 mm basic size may be written as 25 ± 0.02. The maximum permissible size (upper limit) = 25.02 mm and the minimum permissible size (2000 limit) = 24.98 mm

Then, Tolerance = Upper limit – Lower limit

= 25.02 – 24.98 = 0.04 mm. -

Systems of Writing Tolerances: -

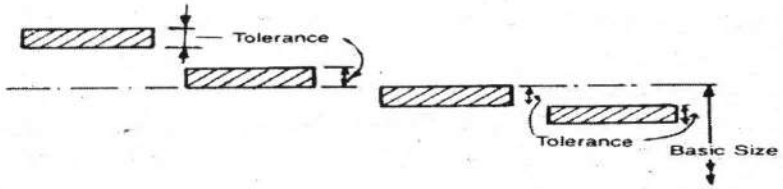
There are two systems of writing tolerances:

i. Unilateral system

ii. Bilateral system

i. Unilateral System

In this system, the dimension of a part is allowed to vary only on one side of the basic size i.e., tolerance lies wholly on one side of the basic size either above or below it.



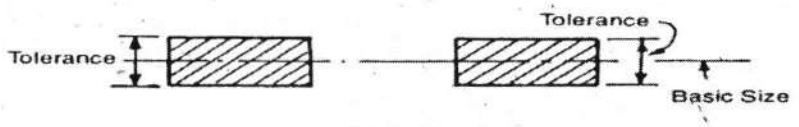
Unilateral Tolerance

Examples of unilateral tolerance are :

$25^{+0.02}_{+0.01}$, $25^{+0.02}_{-0.00}$, $25^{-0.01}_{-0.02}$, $25^{+0.00}_{-0.02}$ etc.

i. Bilateral system

In this system, the dimension of the part is allowed to vary on both the sides of the basic size i.e., the limits of tolerance lie on either side of the basic size; but may not be necessarily equally disposed about it.



Bi-lateral tolerance

e.g., $25^{\pm 0.02}$, $25^{+0.02}_{-0.01}$

In this system it is not possible to retain the same fit when tolerance is varied and .the basic size of one or both of the mating parts is to be varied. This system is used in mass production where machine setting is done for the basic size.

Advantages of Unilateral Dimensioning System

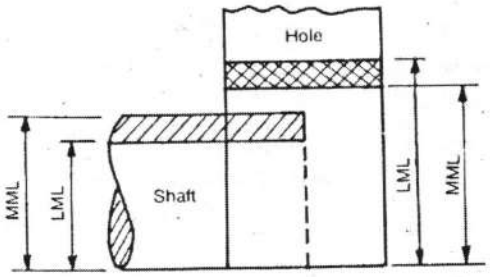
1. Unilateral system of dimensioning is the easiest and simplest method to find the deviations.
2. It can standardize the 'Go' gauge ends Without any difficulty.
3. While machining the mating parts, the tolerance under this system facilitates the operator to a higher extent.

Advantage of Bilateral Dimensioning System

This system is used in mass production, as the setting of machine for basic size is the main criteria.

Maximum and Minimum Metal Limits (or conditions):-

If the tolerance for the shaft is given as $25^{\pm 0.05}$, the upper limit will be 25.05 mm and the lower limit will be 24.94 mm. The Shaft is said to have Maximum Metal Limit (MML) of 25.05 mm, since at this limit the shaft has maximum possible amount of metal. The limit of 24.95 will then be the minimum or "Least
Metal Limit" (LML) because at this limit the shaft will have the least possible amount of metal.

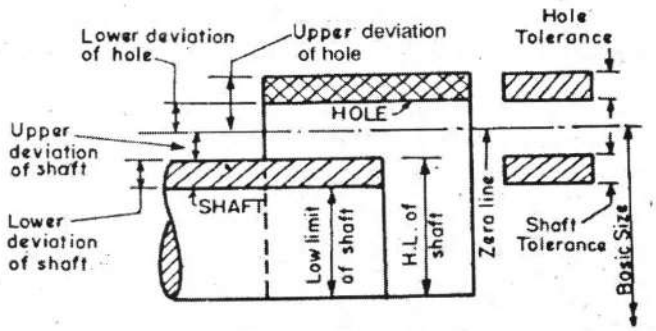


MML and LML

Similarly, if the hole is designated as $30^{\pm 0.05}$mm, the upper limit will be 30.05 mm and the lower limit will be 29.95 mm. Then, the Maximum Metal Limit (MML) of hole will be equal to 29.95, since at this lower limit the hole has the maximum possible amount of metal; while the upper limit of 30.05 mm will be the minimum of 'Least Metal Limit' (LML) of hole as, at this limit the hole will have the least possible amount of metal.

Conventional Diagram of Limits and Fits: -

In the system of limits and fits, we are simply interested in the tolerance on shafts and holes and not in their sizes. Therefore, in the conventional simplified diagram the shaft is shown resting on the hole to make it easy to understand.



Conventional Diagram of Limits

Terminology for Limits and Fits: -

Basic or Nominal Size: It is the standard size of a part with reference to which the limits of variation of a size are determined. It is referred to as a matter of convenience. The basic size is the same for the hole and its shaft. It is the designed size obtained by calculations for strength.

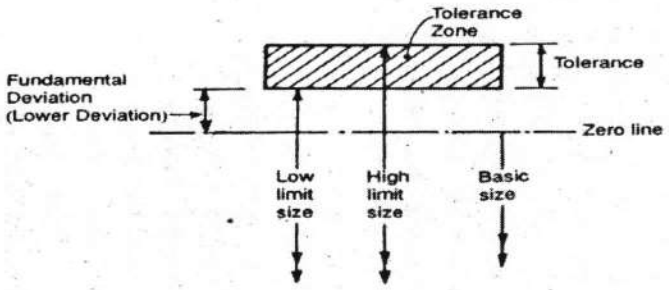
Zero line: It is a straight line drawn horizontally to represent the basic size. In the graphical representation of limits and fits, all the deviations are shown with respect to the zero line (datum line). The positive deviations are shown above the zero line and negative deviations below as shown in Fig (Conventional diagram of limits above).

Deviation: Deviation is the algebraic difference between the size (actual, maximum etc.) and the corresponding basic size.

Upper Deviation: It is the algebraic difference between the upper (maximum) limit of size and the corresponding basic size. It is a positive quantity when the maximum limit of size is greater than the basic size and a negative quantity when the upper limit of size is less than the basic size as shown in Fig. It is denoted by 'ES' for hole and 'es' for a shaft.

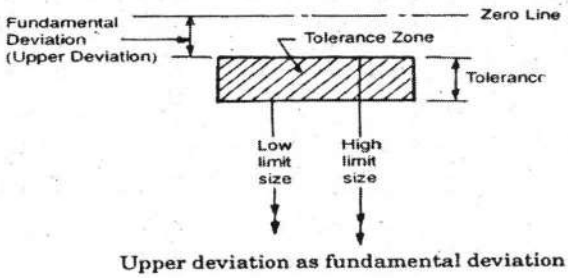
Lower Deviation: It is the algebraic difference between the lower limit of size and the corresponding basic size. It is a positive quantity when the maximum limit of size is greater than the basic size and a negative quantity when the lower limit of size is less than the basic size.

Fundamental Deviation: Fundamental deviation is that one of the two deviations (either the upper or the lower) which is the nearest to the zero line for either hole or a shaft. It fixes the position of the
'Tolerance Zone' in relation to the zero line as shown in Fig.



Lower deviation as fundamental deviation

The fundamental deviation for the hole is denoted by capital letters A, B, C, 2 C and the same for
shaft is denoted by small letters a, b, c zc etc. as explained later.



Upper deviation as fundamental deviation

From Fig it is clear that when the tolerance zone is above the zero line, lower deviation is the fundamental deviation. While, when the tolerance zone is below the zero line, upper deviation is the fundamental deviation.

FIT: -

Fit may be defined as a degree of tightness or looseness, between two mating parts to perform a definite function when they are assembled together.

The fit given the relationship between two mating parts that is shaft and hole. A fit can either provide a fixed joint or movable joint. For example, a shaft running in a bearing can move in relation to it and thus forms a movable joint, whereas, a pulley mounted on the shaft forms a fixed joint.

Types of fits: -

On the basis of positive, zero and negative values of Clearance, there are three basic types of fits:

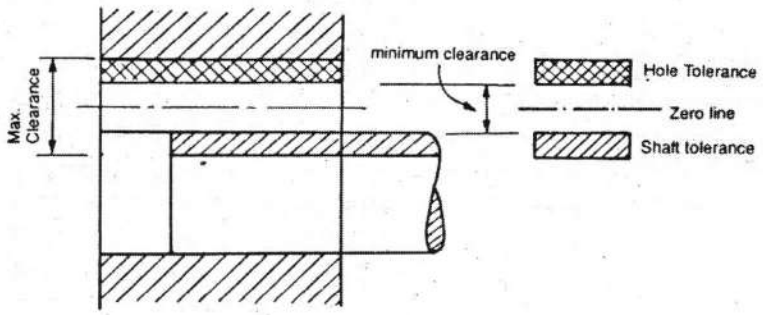
(1) Clearance Fit (2) Transition Fit and, (3) Interference Fit.

These are further classified in the following manner:

Fits

Clearance Fit	*Transition Fit*	*Interference Fit*
(*a*) Slide Fit	(*a*) Push fit	(*a*) Force Fit
(*b*) Easy slide Fit	(*b*) Wringing Fit	(*b*) Tight Fit
(*c*) Running Fit		(*c*) Shrink fit
(*d*) Slack running Fit		
(*e*) Loose running Fit		

1. **Clearance Fit:** In this type of fit aha& is always smaller than the hole i.e., the largest permissible aha& diameter is smaller than the diameter of the smallest hole. So that the shaft can rotate or slide through with different degrees of freedom according to the purpose of mating part.



Clearance Fit

Clearance fit exists when the shaft and the hole are at their maximum metal conditions. The tolerance zone of the hole is above that of the shaft as shown in Fig.

Maximum Clearance: It is the difference between the minimum size of shaft and maximum size of hole.

Minimum Clearance: It is the difference between the maximum size of shaft and minimum size of hole.

i. **Slide Fit:** This type of fit has a very small clearance, the minimum clearance being zero. Sliding fits are employed when the mating parts are required to move slowly in relation to each other e.g., tailstock spindle of lathe, feed movement of the spindle quill in a drilling machine, sliding change gears in quick change gear box of a centre lathe etc.

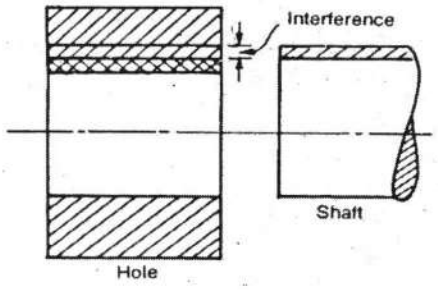
ii. **Easy Slide Fit:** This type of fit provides for a small guaranteed clearance. It serves to ensure alignment between the shaft and hole. It is applicable for slow and non-regular motion, for example, spindle of lathe and dividing heads, piston and slide valves, spigots etc.

iii. **Running Fit:** Running fit is obtained when there is an appreciable clearance between the ~mating parts. The clearance provides a sufficient space for a lubrication film between mating friction surfaces. It is employed for rotation at moderate speed, e.g., gear box bearings, shaft pulleys, crank shafts in their main bearings etc.

iv. **Slack running Fit:** It is obtained when there is a considerable clearance between the mating parts. This type of fit may be required as compensation for mounting errors e.g., arm shaft of I.C. engine, shaft of certifigual pump etc.

v. **Loose running Fit:** Loose running fit is employed for rotation at very high speed, eg., idle pulley on their shaft such as that used in quick return mechanism of a planer.

1. **Interference Fit:** In this type of fit the minimum permissible diameter of the shaft is larger than the maximum allowable diameter of the hole. Thus, the shaft and the hole members are intended to be attached permanently and used as a solid component.



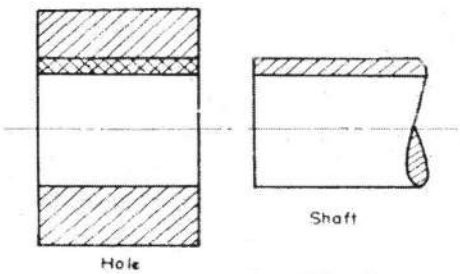
Interference fit

i. **Force Fit:** Force fits are employed when the mating parts are not required to be disassembled during their total service life. In this case the interference is quite appreciable and, therefore, assembly is obtained only when high pressure is applied. This fit, thus, offers a permanent type of assembly, e.g. , gears on the shaft of a concrete mixture, forging machine etc.

ii. **Tight Fit:** It provides less interference than force fit. Tight fits are employed for mating parts that may be replaced while overhauling of the machine, for example, stepped pulleys on the drive shaft of a conveyor, cylindrical grinding machine etc.

iii. **Heavy force and Shrink Fit:** It refers to maximum negative allowance. Hence considerable force is necessary for the assembly. The fitting of the frame on the rim can also be obtained first by heating the frame and then rapidly cooling it in its position.

1. **Transition Fit:** Transition fit lies mid-way between clearance and interference fit. In this type the size limits of mating parts (shaft and hole) are so selected that either clearance or indifference may occur depending upon the actual sizes of the parts. Push fit and wringing fit are the examples of this type of fit.



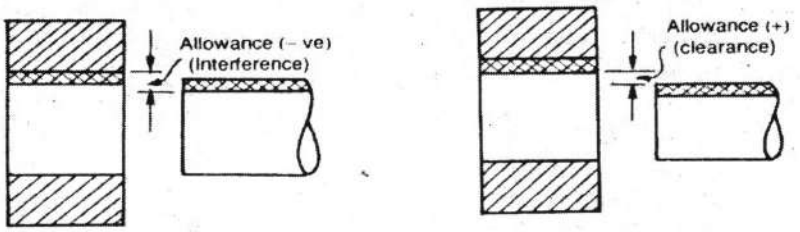
Transition fit

In this type of fit the tolerance zones of the hole and shaft overlap completely or in part.

i. **Wringing Fit:** A wringing fit provides either zero interference or a clearance. These are used where parts can be replaced without difficulty during minor repairs.

ii. **Push Fit:** The fit provides small clearance. It is employed for parts that must be disassembled during operation of a machine for example, change gears, slip bushing etc.

ALLOWANCE: -



Allowance is the prescribed difference between the dimensions of two mating parts for any type of fit.

It is the intentional difference between the lower limit of hole and higher limit of the shaft. The allowance may be positive or negative.

The positive allowance is called clearance and the negative allowance is called interference.

Difference between Tolerance and Allowance: -

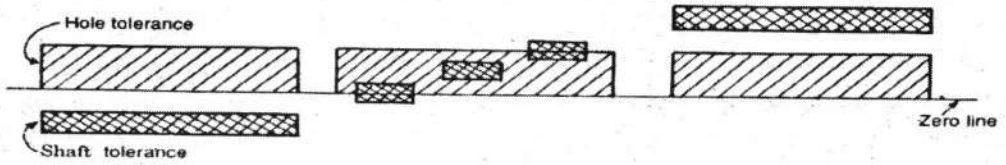
Tolerance	*Allowance*
1. It is the permissible variation in dimension of a part (either a hole or a shaft).	It is the prescribed difference between the dimensions of two mating parts (hole and shaft).
2. It is the difference between higher and lower limits of a dimension of a part.	It is the intentional difference between the lower limit of hole and higher limit of shaft.
3. The tolerance is provided on a dimension of a part as it is not possible to make a part to exact specified dimension.	Allowance is to be provided on the dimension of mating parts to obtain desired type of fit.
4. It has absolute value without sign.	Allowance may be positive (clearance) or negative (interference).

Systems of Obtaining Different Types of Fits: -

There are two systems of fit for obtaining clearance, interference or transition fit. These are:

(1) Hole basis system. (2) Shaft basis system.

1. **Hole basis system:** In the hole basis system the hole is kept constant and the shaft sizes are varied to give the various types of fits. In this system lower deviation of the hole is zero i.e., the low limit of hole is the same as basic size. The high limit of hole and the two limits of size for the shaft are then varied to give the desired type of fit, as shown in Fig.

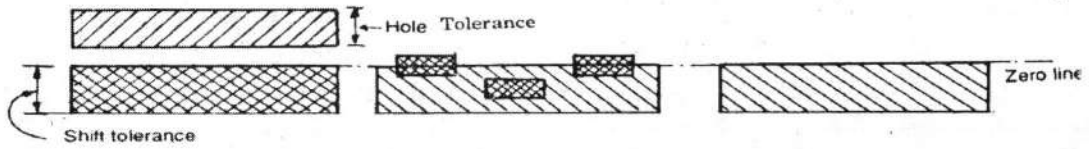


(a) Clearance Fit (b) Transition Fit (c) Interference Fit

Shaft basis System. In the shaft basis system the shaft is kept constant and the sizes of the hole are varied to give various types of fits.

In this system the upper deviation (fundamental deviation) of shaft is zero i.e., the high limit of shaft is the same as basic size and the various fits are obtained by varying the low limit of shaft and both the limits of hole.

1. Shaft basis system:



(a) Clearance Fit (b) Transition Fit (c) Interference Fit

The hole basis system is most commonly used because it is more convenient to make correct holes of fixed sizes, since the standard drills, taps, reamors and broaches etc. are available for producing holes and their sizes are not adjustable. On the other hand size of shaft produced by turning, grinding etc. can be very easily varied.

Shaft basis system is used when the ground bars or drawn bars are readily available. These bars do not require further machining and fit are obtained by varying the sizes of hole.

Difference between 'Hole Basis' and 'Shaft Basis' Systems:-

Hole Basis System	*Shaft Basis System*
1. Size of hole whose lower deviation is zero (H-hole) is assumed as the basic size.	Size of shaft whose upper deviation is zero (*h*-shaft) is assumed as basic size.
2. Limits on the hole are kept constant and those of shaft are varied to obtain desired type of fit.	Limits on the shaft are kept constant and those on the hole are varied to have necessary fit.
3. Hole basis system is preferred in mass production, because it is convenient and less costly to make a hole of correct size due to availability of standard drills and reamers.	This system is not suitable for mass production because it is convenient, time consuming and costly to make a shaft of correct size.
4. It is much more easy to vary the shaft sizes according to the fit required.	It is rather difficult to vary the hole sizes according to the fit required.
5. It requires less amount of capital and storage space for tools needed to produce shafts of different sizes.	It needs large amounts of capital and storage space for large number of tools required to produce holes of different sizes.
6. Gauging of shafts can be easily and conveniently done with adjustable gap gauges.	Being internal measurement, gauging of holes cannot be easily and conveniently done.

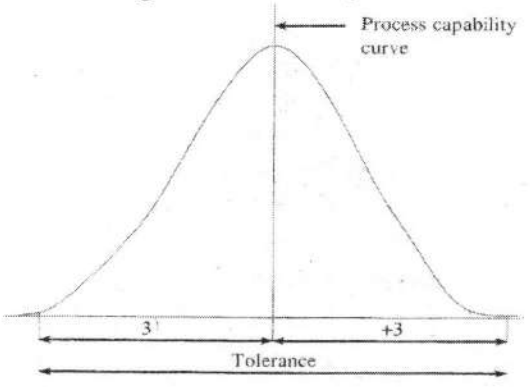
Types of Assemblies: -

There are three ways by which the mating parts can be made to fit together in the desired manner. These are:

(1) Trial and Error (2) Interchangeable Assembly (3) Selective Assembly

1. **Trial and Error:** when a small number of similar assemblies are to be made by the same operator the necessary fit can be obtained by trial and error. This technique simply requires one part to be made to its nominal size as accurately as possible, the other part is then machined with a small amount at a time by trial and error until they fit in the required manner. This method may be used for "one off jobs", tool room work etc. where both parts will be replaced at once.

2. **Interchangeable Assembly:**



It is a system of producing the mating parts in which large number of mating parts are produced. In earlier days, a single operator was confined with number of units and assemble it, which used to take long time and it was not economical. So to reduce the cost and time, mass production 'system was developed. In most production systems, the components are produced in one or more batches by different operations on different machines.

Advantages of Interchangeability

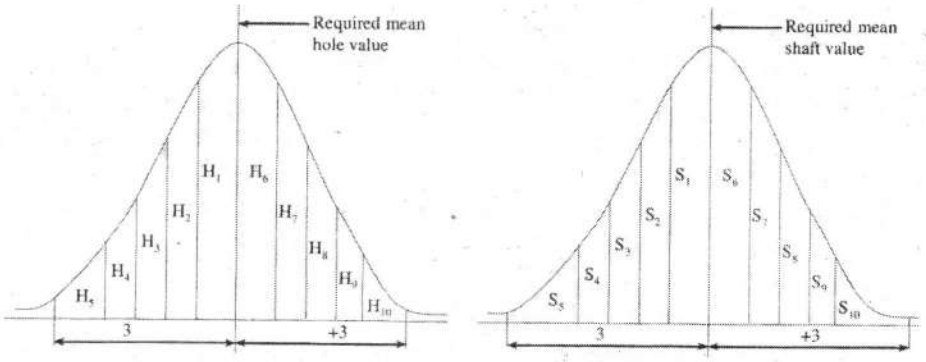
1. This system reduces the production cost and increases the output
2. The operator need not Waste time in assembling the parts by trial-and-error method.
3. Worn out parts and defective parts can be easily replaced.
4. By this method, it is possible to produce mating parts at different places by different operators.
5. Maintenance cost and shut down period is reduced.

1. Selective Assembly:

The need of the consumer is not only the quality, precision and trouble-free products but also the availability of products at economical prices. This is possible by automatic gauging for selective

assembly. In this system, the parts are manufactured to rather wider tolerances and the products produced are classified into various groups according to their sizes by automatic gauging. Classification is made for formatting parts and only matched groups are assembled together.

If hole and shaft are to be produced with in a tolerance of 0.02 mm and both are in the curve of normal distribution, then automatic gauging divides 'them into parts with a 0.002 mm limit for selective assembly of individual pans. Consider an example of piston with cylinder. Let the size of the above be 60 mm and the clearance of 0. 12 mm is required for the assembly. Let the tolerance on bore and piston each be 0.04 mm. Then



Process Capability of Shaft and Hole

Dimension of bore diameter is $60^{\pm 0.12}$

mm and Dimension of piston is

$59.88^{\pm 0.12}$ mm

The pistons and bores may be selected to give the clearance of 0.12 as given below.

Cylinder bore	59.98	60.00	60.02
Piston	59.86	59.88	59.90

What is the difference between international and British standards?

There are a few different standards, British standards, European Standards, American standards, Canadian....

The International Standards (IEC) are worldwide, European ones cover European countries and country specific ones cover that country. Many countries have similar standards.

The ones that cover larger areas (International and European) are used by the countries when they write their standards. An example might be BS EN numbered standards which are British standards that cover the requirements of the European standard. Some are country specific only (BS) and some cover international standards (IEC). It can be confusing but there should be a standard in each country to cover most engineering things.

The main difference is the geographical area that they cover. If you are say working in Britain and follow the BS requirements (or BS EN, or IEC) that applies then you can say that you are working to best

practices and can't be faulted for that.

There will be small differences between them based on custom and practices for the countries that have written them.

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DEPARTMENT OF MECHANICAL ENGINEERING

Remedial Class: I **Date:10/02/2020** **Time: 5.00pm-6:40pm**

Topic:SYSTMS OF LIMITS AND FITS

Indian Standard System of Limits and Fits (IS-919 and 2709)

The Indian standards are in line with the ISO (International Organizations for Standards) recommendations.

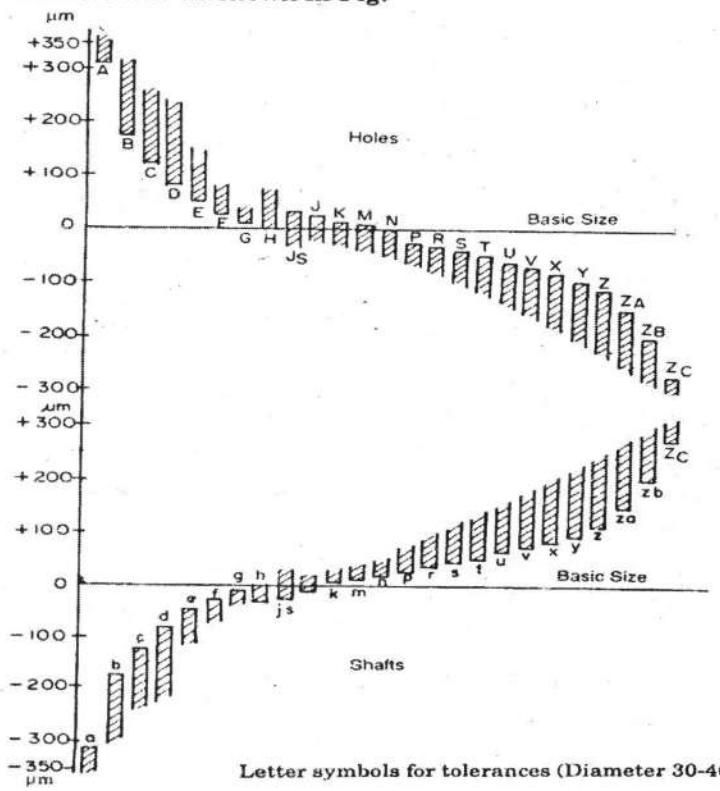
It consists of suitable combination of 18 grades of fundamental tolerances or in other words grades of accuracy for manufacture, and 25 types of fundamental deviations.

The 18 grades of fundamental tolerances are designated as IT01, IT0, IT1 to IT16. While, the fundamental deviations are indicated by letter symbols for both hole and shaft (capital letters 'A to Zc' for holes and small letters a to z_c for shafts. These are : A, B, C, D, E, F, G, H, J_S, J, K, M, N, P, R, S, T, U, V, X, Y, Z , Z_A, Z_B, Z_C).

Innumerable fits ranging from extreme clearance to those of extreme interference can be obtained by a suitable combination of fundamental tolerances and fundamental deviations. Each of 25 holes has a choice of 18 tolerances.

For shafts '*a*' to '*h*' the upper deviation is below the zero line and for shafts '*j*' to '*Zi*' it is above the zero line.

For holes '*A*' to '*H*' lower deviation is above the zero line and for I to Zc it is below the zero line as shown in Fig.



Letter symbols for tolerances (Diameter 30-40 mm)

Problems:-

Example 1. Find the values of allowance, and tolerances for hole and shaft assembly for the following dimensions of mating parts :

Hole : $25^{+0.05}_{+0.00}$ Shaft : $25^{-0.02}_{-0.05}$

Solution.

(*i*) Hole : Tolerance = High limit – Low limit
= 25.05 – 25 = 0.05 mm

(*ii*) Shaft : Tolerance = High limit – Low limit

Now, High limit = 25 – 0.02 = 24.98 mm

Low limit = 25 – 0.05 = 24.95 mm

∴ Tolerance = 24.98 – 24.95 = 0.03 mm

(*iii*) Allowance = Low limit of hole – High limit of shaft
= Maximum metal condition of hole – Maximum metal condition of shaft
= 25.00 – 24.98 = 0.02 mm

Example 2. A 50 mm diameter shaft is made to rotate in the bush. The tolerances for both shaft and bush are 0.050 mm. Determine the dimension of the shaft and the bush to give a maximum clearance of 0.075 mm with the hole basis system.

Solution. In the hole basis system lower deviation of hole is zero therefore low limit of hole = 50 mm

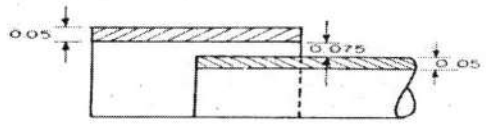


Fig. 9.44.

High limit of hole = Low limit + Tolerance
= 50.00 + 0.050 = 50.050 mm

High limit of shaft = Low limit of hole – Allowance
= 50.00 – 0.075 = 49.025 mm

Low limit of shaft = High limit – Tolerance
= 49.025 – 0.050 = 48.975 mm

Example 3. For each of the following hole and shaft assembly, find shaft-tolerance, hole tolerance and state whether the type of fit is (*i*) clearance (*ii*) transition or (*iii*) interference.

(*a*) Hole : $50^{+0.25}_{+0.00}$ mm Shaft : $50^{+0.05}_{+0.005}$ mm

(*b*) Hole : $30^{+0.05}_{+0.00}$ mm Shaft : $30^{-0.02}_{+0.05}$ mm

(*c*) Hole : $25^{+0.04}_{+0.00}$ mm Shaft : $25^{+0.06}_{+0.04}$ mm

Solution. (*a*) Hole : High limit of hole = 50.025 mm

Low limit of hole = 50.00 mm

∴ Hole tolerance = 50.025 − 50.00 = **0.025** mm ...(*i*)

Shaft : High limit of shaft = 50.05 mm

Low limit of shaft = 50.005 mm

Shaft tolerance = 50.05 − 50.005 = **0.045** mm ...(*ii*)

If we choose high limit of hole with high limit of shaft then

Allowance = 50.025 − 50.05 = − 0.025 (Interference)

If we choose high limit of hole and low limit of shaft then

Allowance = 50.025 − 50.005 = 0.020 mm (Clearance)

Similarly, if we choose low limit of hole and either high limit or low limit of shaft it is clear that there will be interference.

Thus, we conclude that the type of fit is **Transition Fit.**

(*b*) Hole : High limit = 30.05 mm

Low limit = 30.00 mm

∴ Tolerance = 0.05 mm

Shaft : High limit = 30 − 0.02 = 29.98 mm

Low limit = 30 − 0.05 = 29.95 mm

∴ Tolerance = 29.98 − 29.95 = 0.03 mm

If we select high limit of hole and high limit of shaft then

Allowance = 30.05 − 29.98 = 0.07 mm

If we select low limit of hole and high limit of shaft then

Allowance = 30.00 − 29.98 = 0.02 mm

Thus we conclude that the type of fit is **Clearance Fit.**

(*c*) Hole : High limit = 25.04 mm

Low limit = 25.00 mm

Tolerance = 25.04 − 25.00 = 0.04 mm

Shaft : High limit = 25.06 mm

Low limit = 25.04 mm

Tolerance = 25.06 − 25.04 = 0.02 mm

If we select, H.L. of shaft and L.L. of hole then

Allowance = 25.00 − 25.06 = − 0.06 mm

It is clear that for any combination of hole and shaft the allowance will be negative.

Thus we conclude that the type of fit is **Interference Fit.**

Example 4. **In a limit system, the following limits are specified to give a clearance fit between a shaft and a hole.**

$$\text{Shaft } 50^{-0.006}_{-0.020} \text{ mm} \qquad \text{Hole } 50^{+0.030}_{-0.000} \text{ mm}$$

Find : (*a*) Basic size (*b*) Shaft and hole tolerances (*c*) Maximum clearance (*d*) Minimum clearance.

Solution. (*a*) Basic size (same for hole and shaft) = 50 mm

(*b*) Shaft tolerance = H.L. of shaft − L.L. of shaft

= (50 − 0.006) − (50 − 0.02) = **0.014 mm**

Hole tolerance = H.L. − L.L. = 50.030 − 50.00 = 0.030 mm

(*c*) Maximum clearance = H.L. of hole − L.L. of shaft

= 50.030 − (50 − 0.02) = 50.030 − 49.98 = 0.05 mm

(*d*) Minimum clearance = L.L. of hole − H.L. of shaft

= 50.00 − (50 − 0.006) = + 0.006 mm.

Example 5. **In a hole and shaft assembly of 30 mm nominal size, the tolerances for hole and shaft are as specified below :**

$$\text{Hole : } 30^{+0.02}_{-0.000} \text{ mm} \qquad \text{Shaft : } 30^{-0.040}_{-0.070} \text{ mm}$$

Determine :

(*i*) Maximum and minimum clearance obtainable

(*ii*) Allowance

(*iii*) Hole and Shaft tolerance

(*iv*) MML shaft and hole

(*v*) The type of fit.

Solution. (*i*) Maximum clearance = H.L. of hole − L.L. of shaft

= 30.02 − (30 − 0.07) = + 0.09 mm

Minimum clearance = L.L. of hole − H.L. of shaft

= 30.00 − (30 − 0.04) = + 0.04 mm

(*ii*) Allowance = L.L. of hole − H.L. of shaft

= 0.04 mm as above

(*iii*) Hole tolerance = H.L. of hole − L.L. of hole

= 30.02 − 30.00 = 0.02 mm

Shaft tolerance = H.L. of shaft − L.L. of shaft

= 29.96 − 29.93 = 0.03 mm

(*iv*) MML for shaft *i.e.* maximum metal limit for shaft

= H.L. of shaft = 29.96 mm

MML for hole = L.L. of hole = 25.00 mm

(*v*) Since the allowance is positive, it gives a clearance fit.

Example 6. **A hole and mating shaft are to have a nominal assembly size of 50 mm. The assembly is to have a maximum clearance of 0.15 mm and a minimum clearance of 0.05 mm. The hole tolerance is 1.5 times the shaft tolerance. Determine the limits for both hole and shaft :**

By using (*i*) Hole basis system (*ii*) shaft basis system.

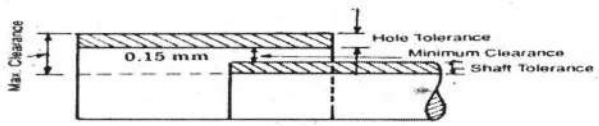


Fig. 9.45.

Solution. **(*i*) Hole Basis system**

In hole basis system lower deviation of hole is zero *i.e.*, the low limit of hole is the same as basic size from Fig. 9.45.

Max. clearance = Hole tolerance + Minimum clearance + Shaft tolerance

Therefore 0.15 = 1.5 × shaft tol. + 0.05 + shaft tol.

∴ 0.15 − 0.05 = shaft tol. (1.5 + 1)

***i.e.*, Shaft tolerance** $= \frac{0.1}{2.5} = 0.04$ **mm**

Hole tolerance = 0.04 × 1.5 = 0.06 mm

Now, low limit of hole = 40 mm (basic size)

∴ High Limit of hole = 40 + 0.06 = 40.06 mm

Thus hole sizes are 40 and 40.06 mm.

We know that minimum clearance = Low limit of hole − High limit of shaft

Therefore, 0.05 = 40.00 − H.L. of shaft

∴ H.L. of shaft = 40 − 0.05 = 39.95 mm

L.L. of shaft = H.L. − Tolerance

= 39.95 − 0.04 = 39.91 mm

Thus, shaft limits are 39.95 mm, and 39.91 mm.

(*ii*) Shaft Basis system

In shaft basis system upper deviation of shaft is zero *i.e.*, H.L. of shaft is the same as basis size = 40.00 mm

L.L. of shaft = H.L. − Tolerance

= 40.00 − 0.05 = 39.95 mm

Max. clearance = H.L. of hole − Low limit of shaft

∴ 0.15 = H.L. of hole − 39.95

∴ H.L. of hole = 39.95 + 0.15 = 40.10 mm

L.L. of hole = H.L. − Tolerance

= 40.10 − 0.06 = 40.04 mm

***Example* 7.** **In an assembly of two parts 50 mm nominal diameter, the lower deviation of the hole is zero and the higher is 5 microns ; while that**

of shaft is – 4 and – 8 microns respectively. Estimate the allowance and state the type of fit of the assembly.

SOLUTION, Hole size : H.L. of hole = 50.005 mm

L.L. of hole = 50.000 mm

Shaft size : H.L. of shaft = 50 – 0.004 = 49.996 mm

L.L. of shaft = 50 – 0.008 = 49.992 mm

Minimum allowance = Lower limit of hole – Higher limit of shaft

= 50.000 – 49.996 = 10.004 mm

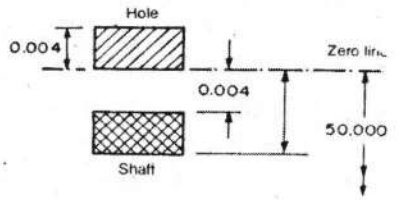


Fig. 7.46.

EXAMPLE 8. A 20 mm diameter shaft and bearing are to be assembled with a clearance fit. The tolerance and allowances are as under :

Allowance = 0.002 mm

Tolerance on hole = 0.005 mm

Tolerance on shaft = 0.003 mm

Find the limits of size for the hole and shaft if :

(*a*) the hole basis system is used (*b*) shaft basis system is used. The tolerances are disposed of unilaterally.

SOLUTION. *For Hole Basis System :*

Hole size :

Higher limit of hole = 20.005 mm

Lower limit of hole = 20.000 mm

Now, allowance given is + 0.002 mm

Therefore, Higher limit of shaft = Lower limit of hole – Allowance

= 20.000 – 0.002 = 19.998 mm

and, lower limit of shaft = Higher limit of shaft – Tolerance

= 19.998 – 0.003 mm = 19.995 mm

For Shaft Basis System :

Shaft size ; High limit = 20.000 mm and

Lower limit = 20.000 – 0.003 = 19.997 mm

Allowance = + 0.002 (given)

Therefore, Low limit of hole = High limit of size + Allowance

= 20.000 + 0.002 = 20.002 mm

and High limit of hole = 20.002 + 0.005 = 20.007 mm

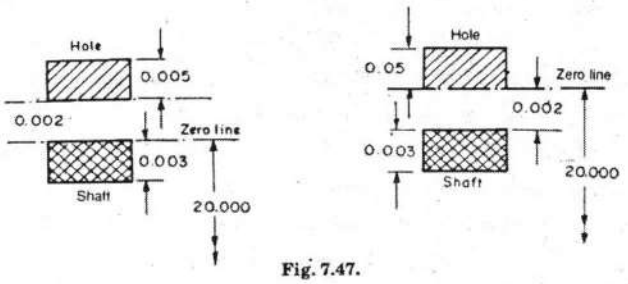


Fig. 7.47.

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DEPARTMENT OF MECHANICAL ENGINEERING

QUALITY ANALYSIS OF INTERNAL EXAM-1 QUESTIONS

I Internal Test-I Sem. of 2019-20

Subject: Metrology **Class: III/IV (MECH-A, B)** **Date:20-01-20**

Time:100mins **Max Marks: 30M**

Answer all the Questions.

Q.No.	Questions	Marks	CO	BL
1.A	A 50 mm diameter shaft and bearing are to be assembled with a clearance fit. The tolerance and allowance are as under. Allowance = 0.035 mm Tolerance on hole = 0.025 mm Tolerance of shaft = 0.017 mm Find the limits of size for the hole and shaft if (i)Hole basis system is used (ii) Shaft basis system is used	6	CO1	L2
1.B	Differentiate between unilateral and bilateral tolerance with examples?	4	CO1	L3
2.A	With the help of sketch explain the working of an external micrometer?	5	CO2	L3
2.B	Design the general type GO and NO-GO gauge for components having 20H7/f8 fit Given: i=0.45D1/3+0.001D , where D is the geometric mean of the lower and upper limits of diameter step in which the diameter consideration lies, D is in mm, The standard tolerance for IT7=16i and IT8=25i. Wear allowance is 10% of Gauge tolerance.	5	CO2	L4
3.A	Compare Michelson's and NPL flatness interferometers?	5	CO2	L3
3.B	Explain with a neat sketch the principle and construction of an Auto collimator.	5	CO2	L2

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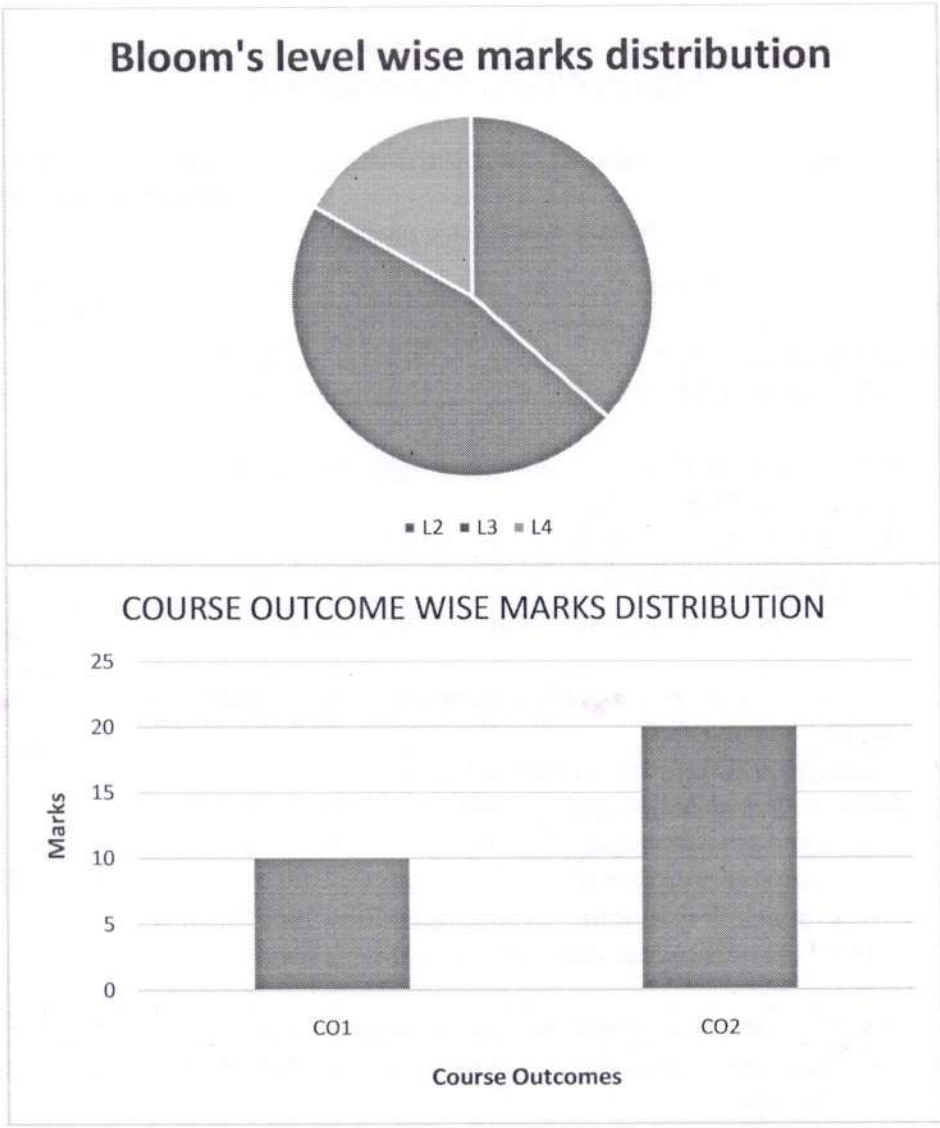

BL – Bloom's Taxonomy Levels
(1- Remembering, 2- Understanding, 3 – Applying, 4-Analysing, 5 – Evaluating, 6-Creating)
CO – Course Outcomes
PO – Program Outcomes

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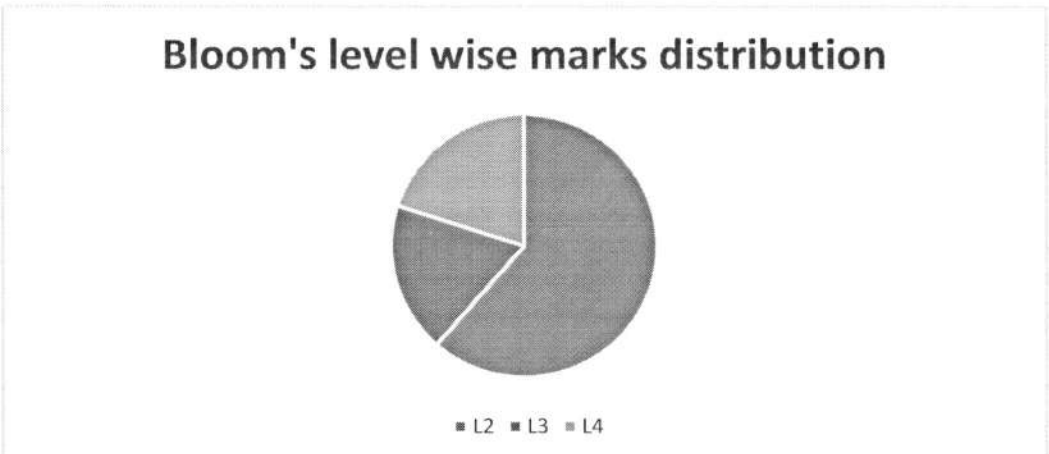
DEPARTMENT OF MECHANICAL ENGINEERING

ASSIGNMENT-1

This Assignment corresponds to Unit No. 1, 2, 3.

BATCH-1

Q.No.	Questions	Marks	CO	BL
1.	a) Determine limit dimensions for a clearance fit between mating parts of diameter 40mm, providing a minimum clearance of 0.10 mm with a tolerance on the hole equal to 0.025mm and on shaft 0.05mm using both systems.	6	1	3
	b) Explain briefly about interchangeable manufacturing and selective assembly?	8	1	2
2.	a) Explain with neat sketches the variants of sine bars and their applications.	7	2	2
	b) Write detailed notes on progressive and positional limit gauges.	7	2	2
3.	a) Design the general type of Go and No-Go gauges for components having 20H7f8 fit. Given gauge tolerance = work tolerance 10% of work tolerance. Assume the data following: Upper deviation of shaft 'f' is =-5.5D0.4,The standard tolerance unit i = 0.45D(1/3)+0.001D , 20 mm falls in diameter steps of 18-30 mm, The standard tolerance for IT7=16i and IT8=25i.	14	2	4
4.	a) Explain flatness interferometer with neat sketch and write its applications.	7	2	3
	b) Explain how flatness errors of lapped surfaces are measured with an optical flat.	7	2	2
5.	a) Describe with a neat sketch the working principle and the applications of Toolmaker's microscope.	7	2	2
	b) Explain about principle of interference of light.	7	2	2



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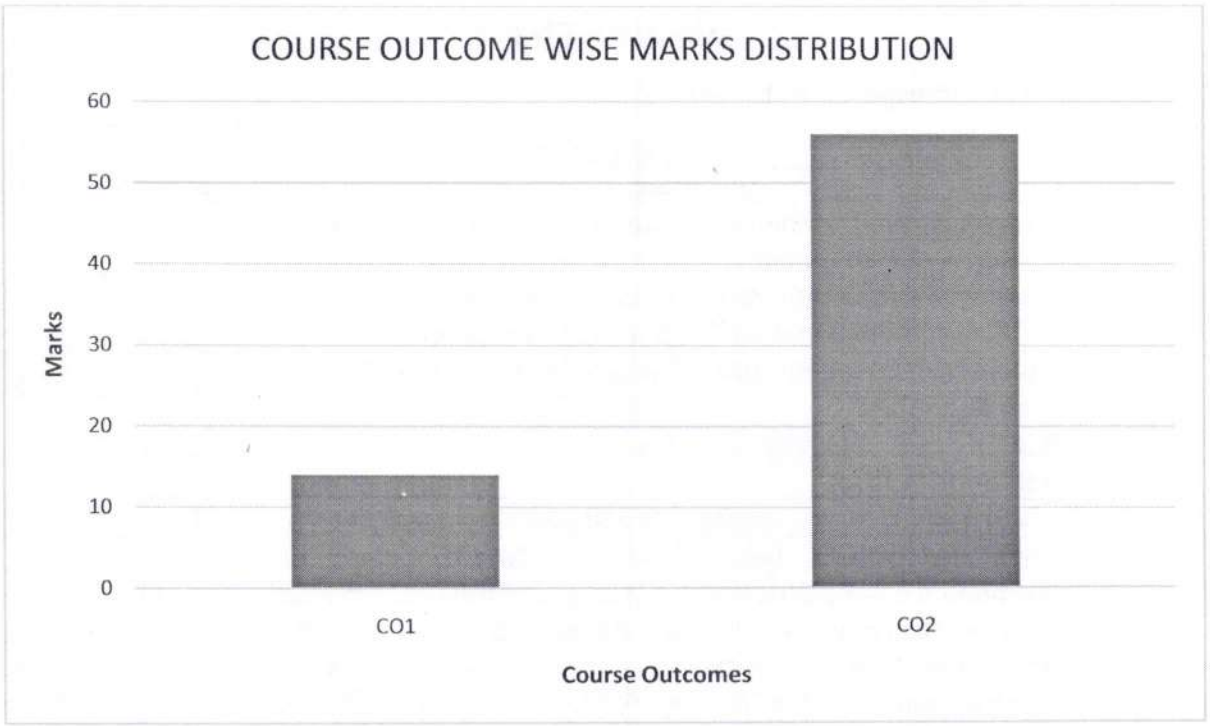

Ch. Chandra

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DEPARTMENT OF MECHANICAL ENGINEERING

QUALITY ANALYSIS OF INTERNAL EXAM-2 QUESTIONS

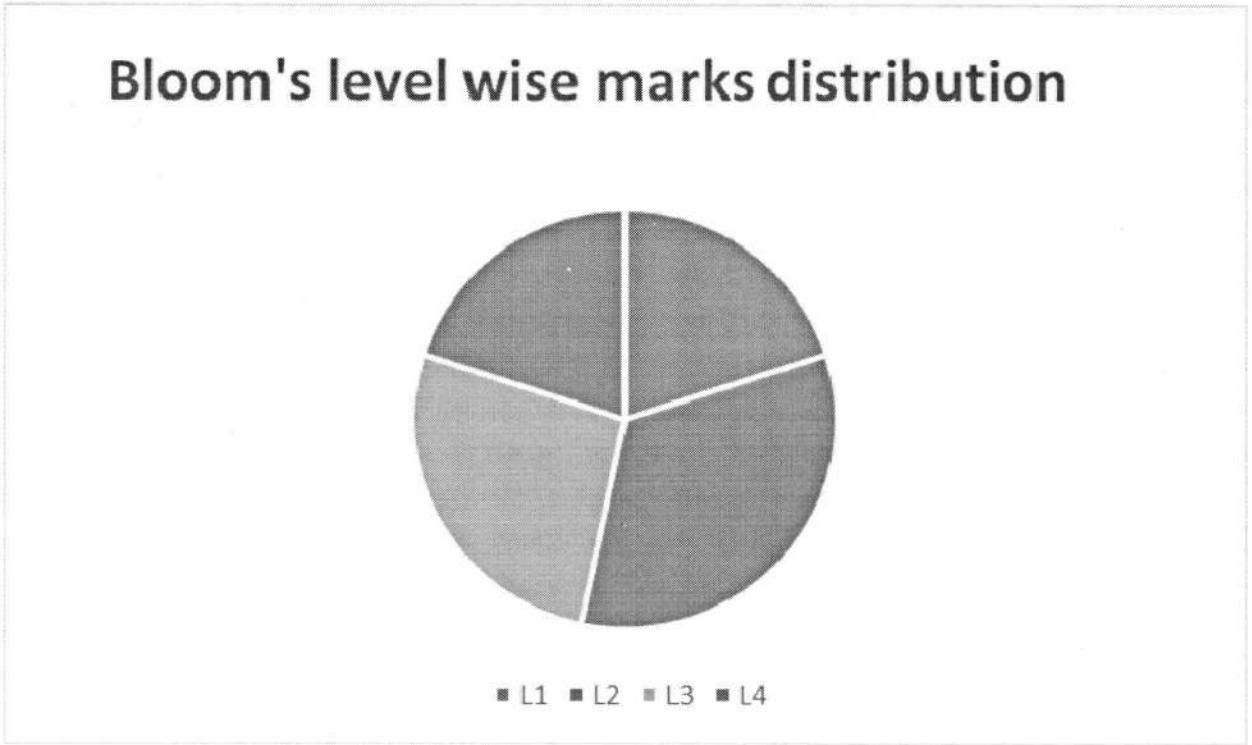
II Internal Test- II Sem.of2019-20

Subject: Metrology **Class: III/IV (MECH-A, B)** **Date:14-10-20**

Time:100mins **Max Marks: 30M**

Answer all the Questions.

Q.No.	Questions	Marks	CO	BL
1.A	Describe the construction and working of Taylor–Hobson Talysurf with the help of neat sketch.	6	CO3	L1
1.B	Distinguish between comparator and measuring machine.	4	CO3	L3
2.A	Distinguish between Two wire method and three wire method w.r.t effective diameter.	4	CO4	L3
2.B	Analyze the parameters that are checked with the help of Parkinson's gear tester.	6	CO4	L4
3.A	Illustrate the construction and working principle of an auto collimator.	5	CO5	L2
3.B	Specify the various alignment tests performed on lathe machine and discuss any two of them in detail?	5	CO5	L2



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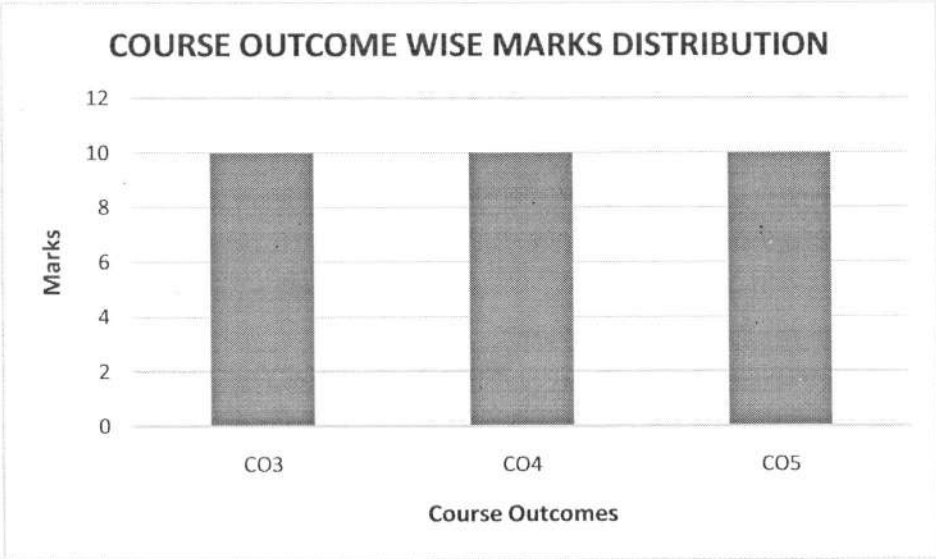

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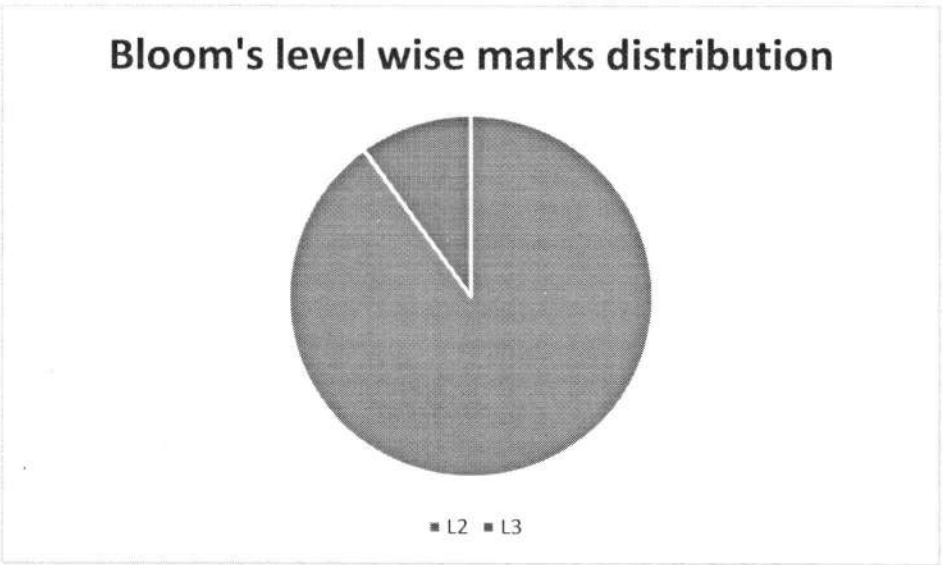
DEPARTMENT OF MECHANICAL ENGINEERING

ASSIGNMENT-2

This Assignment corresponds to Unit No. 4, 5, 6.

BATCH-1

Q.No.	Questions	Marks	CO	BL
1.	a) With help of neat sketch describe the construction and working of Taylor–Hobson Talysurf.	6	3	2
	b) Describe the working and uses of visual gauging heads.	8	3	2
2.	a) With a neat sketch explain how the simple effective diameter of a screw thread maybe checked using the two wire method.	7	4	3
	b) Describe the following terms in screw threads: (i) Major diameter (ii) Minor diameter (iii) Tooth thickness and (iv) Pitch	7	4	2
3.	List out the advantages and disadvantages of three wire method when compared with two wire method?	14	4	2
4.	Describe the Parkinson's gear tester and state its limitations.	14	4	2
5.	a) Define flatness. Describe any one method of testing flatness of a surface.	7	5	2
	b) Explain the parallelism of tailstock sleeve of a lathe machine to saddle movement?	7	5	2



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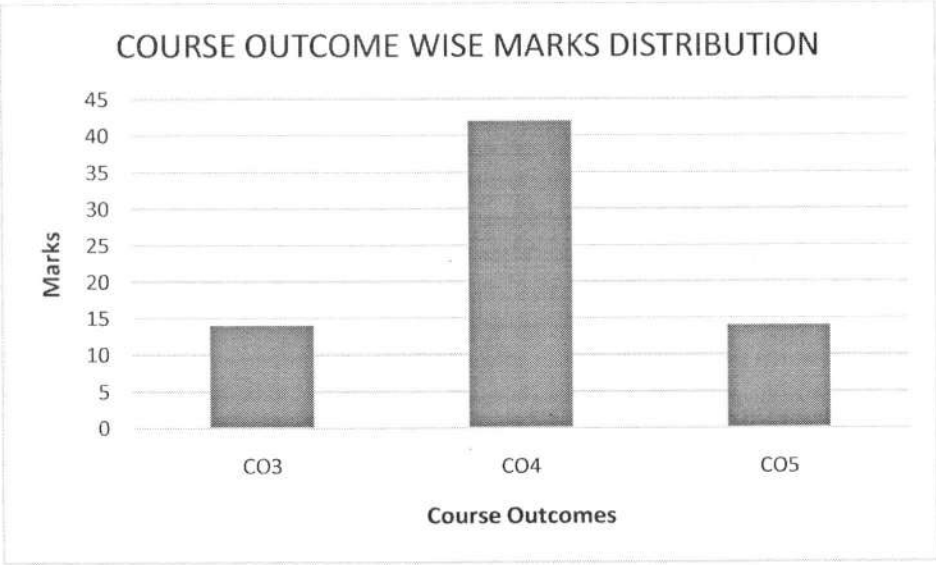

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Scheme of Evaluation

1.

a) For hole basis system — 3M

For shaft basis system — 3M

b) For any four differences — 4M

2. a) sketch — 2M

working — 3M

b) Design of GO and NO GO — 5M.

3. a) For any Five comparisions — 5M

b) sketch — 2M

principle and construction — 3M

Sheme of Evaluation

1.
a) construction and working — 4M.
Neat sketch — 2M
b) For Any Four differences — 4M

2. a) For any four differences — 4M
b) for Analysis with figs — 6M

3. a) For construction — 2M
working principle — 1M
b) For specification any four alignment tests performed on lathe machine — 2M
Discussion of any two of them — 1M.

Code No: R1632031 **R16** SET - 1

III B. Tech II Semester Regular Examinations, April/May - 2019

METROLOGY

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

PART –A

1. a) What is bilateral tolerance system? [2M]
   b) State the principle of micrometer and its least count? [3M]
   c) What do you mean by interferometers? [2M]
   d) Differentiate between primary and secondary texture? [2M]
   e) Explain how various elements of screw thread are measured? [3M]
   f) Name some instruments required for alignment tests. [2M]

PART -B

2. a) A 50 mm diameter shaft and bearing are to be assembled with a clearance fit. The tolerance and allowance are as under. [8M]
   Allowance = 0.035 mm Tolerance on hole = 0.025 mm
   Tolerance of shaft = 0.017 mm
   Find the limits of size for the hole and shaft if
   (i) Hole basis system is used (ii) Shaft basis system is used
   b) Describe interchangeable assembly with suitable example. State its advantages. [6M]

3. a) Write detailed notes on progressive and positional limit gauges? [6M]
   b) Explain the construction and uses of i) Vernier bevel protractor ii) Sine bar [8M]

4. a) Explain NPL flatness interferometer with neat sketch and write its applications? [7M]
   b) Describe the working of an optical projector? What are its applications? [7M]

5. a) With help of neat sketch describe the construction and working of Taylor –Hobson Taly surf. [7M]
   b) Describe the working and uses of visual gauging heads. [7M]

6. a) With a neat sketch explain how the simple effective diameter of a screw thread may be checked using the two wire method. [7M]
   b) Describe the following terms in screw threads: [7M]
   (i) Major diameter, (ii) Minor diameter, (iii) Tooth thickness and (iv) Pitch

7. a) Define flatness. Describe any one method of testing flatness of a surface. [8M]
   b) Explain the parallelism of tailstock sleeve of a lathe machine to saddle movement? [6M]

*****

Code No: R1632031 **R16** SET - 2

III B. Tech II Semester Regular Examinations, April/May - 2019

METROLOGY

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

PART –A

1.	a)	What is meant by unilateral tolerance system?	[2M]
	b)	Name some linear measurement instruments.	[2M]
	c)	State the principle of interference?	[3M]
	d)	List the advantages of electronic comparators?	[2M]
	e)	What do you mean by error in screw threads?	[3M]
	f)	What is the purpose of performing alignment test on machine tool?	[2M]

PART -B

2.	a)	Determine limit dimensions for a clearance fit between mating parts of diameter 40 mm, providing a minimum clearance of 0.10 mm with a tolerance on the hole equal to 0.025mm and on shaft 0.05mm using both systems.	[6M]
	b)	Explain briefly about interchangeable manufacturing and selective assembly?	[8M]
3.	a)	With the help of sketches explain the working of an external micrometer?	[7M]
	b)	Explain the following in connection with gauge design: (i) Gauge tolerance (ii) Wear allowance.	[7M]
4.	a)	Explain briefly about optical flat with a neat sketch?	[7M]
	b)	Explain the working of michelson's interferometer with neat sketch.	[7M]
5.	a)	Describe the working principle of profilograph?	[7M]
	b)	Explain the basic principle of a pneumatic comparator with neat sketch.	[7M]
6.	a)	Describe the parkinson's gear tester and state its limitations.	[8M]
	b)	List out the advantages and disadvantages of three wire method when compared with two wire method?	[6M]
7.	a)	Explain with suitable sketches the various alignment tests performed on Milling machine?	[8M]
	b)	Explicate the utility of straight edge and surface plate in laboratories?	[6M]

*****

Code No: R1632031 **R16** SET - 3

III B. Tech II Semester Regular Examinations, April/May - 2019

METROLOGY

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

PART –A

1.	a)	Define limit and tolerance.	[2M]
	b)	State the taylor's principle of gauge design.	[2M]
	c)	What are uses of optical flat?	[2M]
	d)	How is surface roughness calculated by CLA and R.M.S methods?	[3M]
	e)	What are the applications of flange micro meter?	[3M]
	f)	Distinguish between alignment tests and performance tests on machine tools?	[2M]

PART -B

2.	a)	Explain briefly different types of fits with necessary sketches?	[7M]
	b)	Differentiate between unilateral and bilateral tolerance with examples? Explain the need for providing tolerance on a dimension.	[7M]
3.	a)	Explain the need for gauge maker's tolerance? Discuss how the wear allowance is provided on gauges?	[7M]
	b)	Explain with a neat sketch, the construction and uses of Vernier bevel protractor?	[7M]
4.	a)	With the help of neat sketch explain the construction and working of tool maker's microscope.	[8M]
	b)	Explain the working of NPL gauge interferometer with neat sketch.	[6M]
5.	a)	The heights of peaks and valleys of 20 successive points on a surface are 35, 25, 40, 22, 37, 19, 41, 21, 42, 18, 42, 24, 44, 25, 40, 18, 40, 18, 39, and 21 microns respectively, measured over a length 20mm. Determine CLA and RMS values of roughness surface?	[7M]
	b)	Differentiate between a comparator and measuring machine? Discuss the Fundamental requirements of a comparator.	[7M]
6.	a)	What are the various errors in screw threads? Discuss sources of these errors and precautions need to minimize or completely eliminate these errors	[7M]
	b)	Explain the gear terminology with a neat sketch?	[7M]
7.	a)	List out and briefly explain any two flatness measurement instruments?	[6M]
	b)	Explain with suitable sketches the various alignment tests performed on drilling machine?	[8M]

*****

Code No: R1632031 **R16** SET - 4

III B. Tech II Semester Regular Examinations, April/May - 2019

METROLOGY

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

PART –A

1.	a)	What is hole and shaft basis system	[2M]
	b)	Mention few applications of sine bar?	[2M]
	c)	List the uses of auto collimator.	[2M]
	d)	Define Lay and explain different types of lay with a neat sketch?	[3M]
	e)	Describe in detail various types of errors occurring in gears?	[3M]
	f)	Name the various instruments required for performing the alignment tests on machine tool?	[2M]

PART -B

2.	a)	Determine the dimensions and tolerances of the shaft and hole having the size of 25H7/f8. 25mm falls in diameter steps of 18-30. Also indicate the type of fit and show the tolerances with sketch. Assume the following data, The fundamental deviation for shaft 'f' is $-5.5D^{0.41}$, The standard tolerance unit $i=0.45\sqrt[3]{D}+0.001D$, where D is the geometric mean of the lower and upper limits of diameter step in which the diameter consideration lies, D is in mm, The standard tolerance for IT7=16i and IT8=25i.	[7M]
	b)	Define fit and describe various types of fits in brief?	[7M]
3.	a)	What are limit gauges? Sketch and explain any two types of the limit gauges.	[7M]
	b)	What is the difference between line standard and end standard? Explain them with examples.	[7M]
4.	a)	Compare Michelson's and NPL flatness interferometers?	[7M]
	b)	Explain how flatness errors of lapped surfaces are measured with an optical flat.	[7M]
5.	a)	Describe the various numerical methods for assessment of surface Finish?	[7M]
	b)	Describe the working principle of a solex pneumatic comparator.	[7M]
6.	a)	Describe a gear tooth vernier caliper and show how it is used for gears?	[7M]
	b)	With a neat sketch explain how the effective diameter of a screw thread may be checked using the three wire method?	[7M]
7.	a)	What are the various alignment tests performed on lathe machine and discuss any two of them in detail?	[8M]
	b)	Describe the various methods for checking flatness of machined surfaces.	[6M]

*****

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DEPARTMENT OF MECHANICAL ENGINEERING

ATTAINMENTS DATA SHEET

COURSE TITLE	: Metrology		
COURSE CODE	: 321	REGULATION	: R-16
PROGRAM	: B.TECH - MECHANICAL	ACADEMIC YEAR	: 2019-20
YEAR OF STUDY	: III/IV	SEMESTER	: VI
HANDLERS	: SRI CHANDRA RAO CHANDU / DR. K LALIT NARAYAN		

COURSE OUTCOMES ATTAINMENTS

SEC. / CO	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8
A	2.35	2.35	2.83	2.59	2.59		-	-
B	2.35	2.35	2.83	2.59	2.59	-	-	-
AVERAGE	2.35	2.35	2.83	2.59	2.59	-	-	-

POs & PSOs ATTAINMENTS

SEC. / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
A	2.55	-	-	-	-	-	2.54	-	-	-	-	2.54	-	2.54
B	2.55	-	-	-	-	-	2.54	-	-	-	-	2.54	-	2.54
AVERAGE	2.55	-	-	-	-	-	2.54	-	-	-	-	2.54	-	2.54

K. Lalit Narayan
MODULE COORDINATOR

K. Lalit Narayan
COURSE COORDINATOR

H.O.D. MECH. ENGG

Head of the Department
Mechanical Engineering

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DEPARTMENT OF MECHANICAL ENGINEERING

ATTAINMENT OF COs

SIR C R REDDY COLLEGE OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE:METROLOGY COURSE CODE:321

OVERALL ATTAINMENT OF COURSE OUTCOMES (DIRECT & INDIRECT)

CRITERIA \ COs	1	2	3	4	5					
CIE	1	1	3	2	2					
SEE	2.70	2.70	2.70	2.70	2.70					
Direct CO attainment (CIE+SEE)	2.19	2.19	2.79	2.49	2.49					
In-Direct CO Attainment %(CES)	90	82	86	87	86					
In-Direct CO Attainment (CES)	3	3	3	3	3					
Overall CO attainment	2.35	2.35	2.83	2.59	2.59					
Target for A.Y: 2019-2020	2.1	2.1	2.1	2.1	2.1					
Target Met or Not Met (M/NM)	M	M	M	M	M					
Target for next year 2020-2021	2.2	2.2	2.2	2.2	2.2					

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DEPARTMENT OF MECHANICAL ENGINEERING

ATTAINMENT OF POs

CO ATTAINMENT	COs\ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	
2.352	C321.1	2						2					2		3	
2.352	C321.2	2						2					2		3	
2.832	C321.3	2						2					2		3	
2.592	C321.4	3						2					2		3	
2.592	C321.5	3						2					2		3	
COURSE-PO MAPPING	C321	2.40	-	-	-	-	-	2.00	-	-	-	-	2.00	-	3.00	
	COURSE - PO ATTAINMENT	2.55	-	-	-	-	-	2.54	-	-	-	-	2.54	-	2.54	

SIR C R REDDY COLLEGE OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
COURSE :METROLOGY - COURSE CODE :321

COURSE END SURVEY

A.Y: 2019- 2020
FOR JNTUK R16 REGULATIONS
BATCH: 2017-2021

COURSE OUTCOMES	1	2	3	4	5											
ATTAINMENT	80	82			84											
CO Nos	1	2	3	4	5											
Question No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
S.NO \ MAX SCALE VALUE	4.0	4.0	4.0	4.0	4.0											
1	4.0	4.0	4.0	4.0	4.0											
2	3.0	3.0	3.0	2.0	3.0											
3	4.0	4.0	2.0	4.0	2.0											
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7	4.0	4.0	4.0	4.0	4.0											
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114	3.0	2.0	3.0	4.0	3.0											
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121	3.0	4.0	3.0	4.0	3.0											
122	3.0	4.0	4.0	3.0	4.0											

Q.No	COURSE END SURVEY QUESTION DESCRIPTION	CO
1	Are you able to Design parts, tolerances and fits for var	1
2	Are you able to Explain the principles of linear, angular	2
3	Are you able to Explain measurement of surface finish	3
4	Are you able to Explain the concepts of measurement f	4
5	Are you able to Evaluate the quality of different machir	5

ACADEMICYEAR: 2019-20 SEMESTER:II

SAMPLESCRIPTS

MID-1

SIR C.R.REDDY COLLEGE OF ENGINEERING
ELURU - 534 007

Regd. No.	1	7	B	8	Y	A	0	3	H	5	-	

Class : III/IV B.Tech Branch : Mechanical Date : 20-01-20

Subject : Metrology Signature of the Invigilator :

Marks Awarded : 27/30 Signature of the Subject Teacher :

Q. No	1.a	1.b	2.a	2.b	3.a	3.b	Total
Marks	6	4	5	4	5	3	27

1a) Given that dia of shaft and bearing (basic size) = 50 mm

Allowance = 0.035 mm

Tolerance on hole = 0.025 mm

Tolerance on shaft = 0.017 mm

(i) Hole basis System

For Hole :-

In hole basis system Lower limit of hole is equal to the basic size of hole

Therefore,

Lower limit of hole = (50 + 0.00) mm = 50 mm

Now,

Tolerance = Higher limit of hole − Lower limit of hole

0.025 = Higher limit of hole − 0.00

⇒ Higher limit of hole = 0.025 mm

Limit of size of hole = $50^{+0.025}_{+0.00}$ $50^{+0.025}_{+0.00}$

For Shaft

We know that

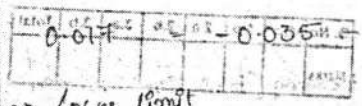
Allowance = Lower limit of hole − Higher limit of Shaft

$0.035 = 0.00 - $ Higha limit of shaft

$\Rightarrow$ Higha limit of shaft $= -0.035$ mm

Now

Tolerance of shaft = Higha limit of shaft − Lower limit of shaft



$\Rightarrow$ Lower limit of shaft $= -0.052$ mm

Now, Limit of size of shaft $= 50^{-0.035}_{-0.052}$

(ii) Shaft basis system

(1) For shaft

In shaft basis system higha limit of shaft is equal to the basic size of the shaft

Therefore; higha limit of shaft $= (50+0.00) = 50$ mm

NOW

Tolerance of shaft = Higha limit of shaft − Lower limit of shaft

$0.017 = 0.00 -$ Lower limit of shaft

Lower limit of shaft $= -0.017$

Limit of size of shaft $= 50^{-0.017}$

For hole

Now, Allowance = Lower limit of hole − higha limit of shaft

$\rightarrow 0.035 =$ Lower limit of hole $- 0.00$

$\Rightarrow$ Lower limit of hole $= +0.035$ mm.

Now

Tolerance of hole = higha limit of hole − Lower limit of hole

$0.025 =$ higha limit of hole $- 0.035$

Higha limit of hole $= +0.06$

Limit of size of hole $= 50^{+0.06}_{+0.035}$

16)

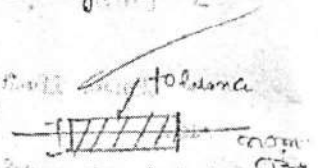
Uni-lateral tolerance	Bi-lateral tolerance
1) In uni-lateral the variation of tolerance is only one side of the nominal size	1) In Bi-lateral the variation of tolerance is both sides of the nominal size
2) The example as $20^{+0.25}_{+0.00}$	2) The example as $20^{-0.05}_{+0.25}$ $20^{-1.00}_{+0.25}$

3) uni lateral is used in the interchangeability components

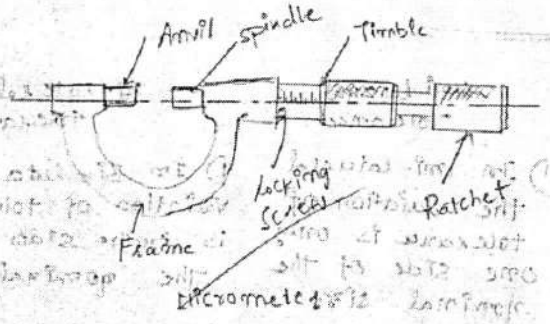
1) In uni lateral the only mating part can be changed ie. main product can be used

3) Bilateral is used in the fixed type of components

4) In bilateral the both parts should be changed.



2a) External Micrometer



Principle :-

The external micrometer is based on the principle of screw and not mechanism. The timble moves the in linear direction for pitch of the spindle

The external micrometer is used for accurate results and used used for measuring diameters and cylinder and linear measurement of slip gaoges. The circumference of the spindle is divided into equal parts then the linear measurement can be given by the pitch moved ova the spindle. The least count that can be measured by the micrometer is 0.1 mm

$$\text{Least count} = \frac{\text{Main Scale reading}}{\text{No. of division}}$$

$$= \frac{5}{50}$$

$$= 0.1 \text{ mm}$$

Parts of the micrometer :-

1) Frame
2) Anvil
3) spindle
4) Timble
5) Ratchet
6) Locking screw

1) Frame :-

The frame holds the whole set up of the micrometer i.e anvil and spindle and give support

2) Anvil

The anvil is fixed at one end of the micrometer and spindle can be movable

3) Spindle

It is movable element of the micrometer and it will loosen and tighten the object to be measured

4) Ratchet

The object is fixed by rotating the ratchet to the extent of the object

5) Timble

The timble in which circular readings can be noted down per pitch of spindle

Types of external micrometer

1) Outside micrometer
2) Inside micrometer
3) Screw-thread micrometer
4) Depth gauge micrometer

2b) Given that

Gauge i 20 H9 / f8

$i = 0.45 D^{1/3} + 0.001 D$

IT 7 = 16i

Wear allowance is 10% of Gauge tolerance

Now,

$D = \sqrt{18 \times 30} = 23.23$ microns

$i = 0.45 \times (23.23)^{1/3} + 0.001 \times (23.23)$

$= 1.307$

Now,

IT 7 = 16i = $16 \times 1.307 = 20.912 = 0.020$ mm

IT 8 = 25i = $25 \times 1.307 = 32.675 = 0.032$ mm

Now,

Limit of hole = $20^{+0.020}_{+0.000}$

Fundamental deviation of shaft

$es = -5.5 D^{1.4} = -5.5 D^{1.4} = 0.02$

Limit of shaft = $50^{-0.02}_{-0.052}$

Now,

Work tolerance = 0.05 mm

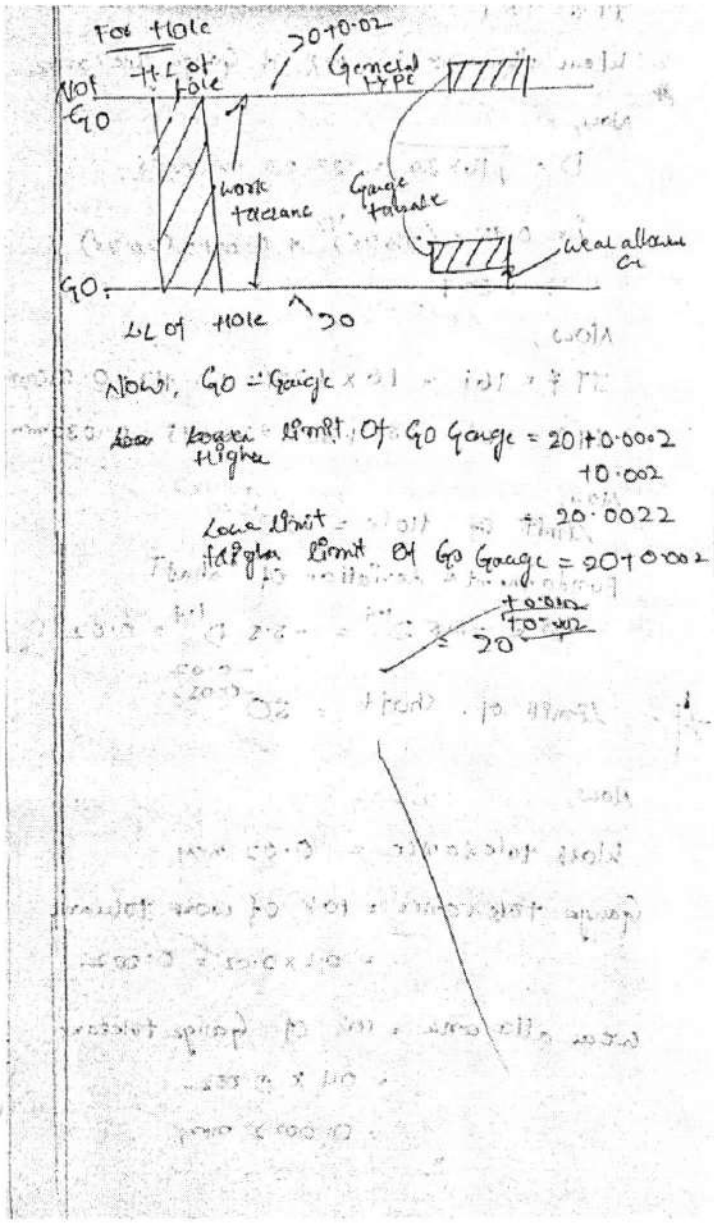
Gauge tolerance = 10% of work tolerance

$= 0.1 \times 0.02 = 0.002$

Wear allowance = 10% of Gauge tolerance

$= 0.1 \times 0.002$

$= 0.0002$ mm



Now, GO = Gauge

Lower Limit of GO Gauge = 20 + 0.002

Higher + 0.002

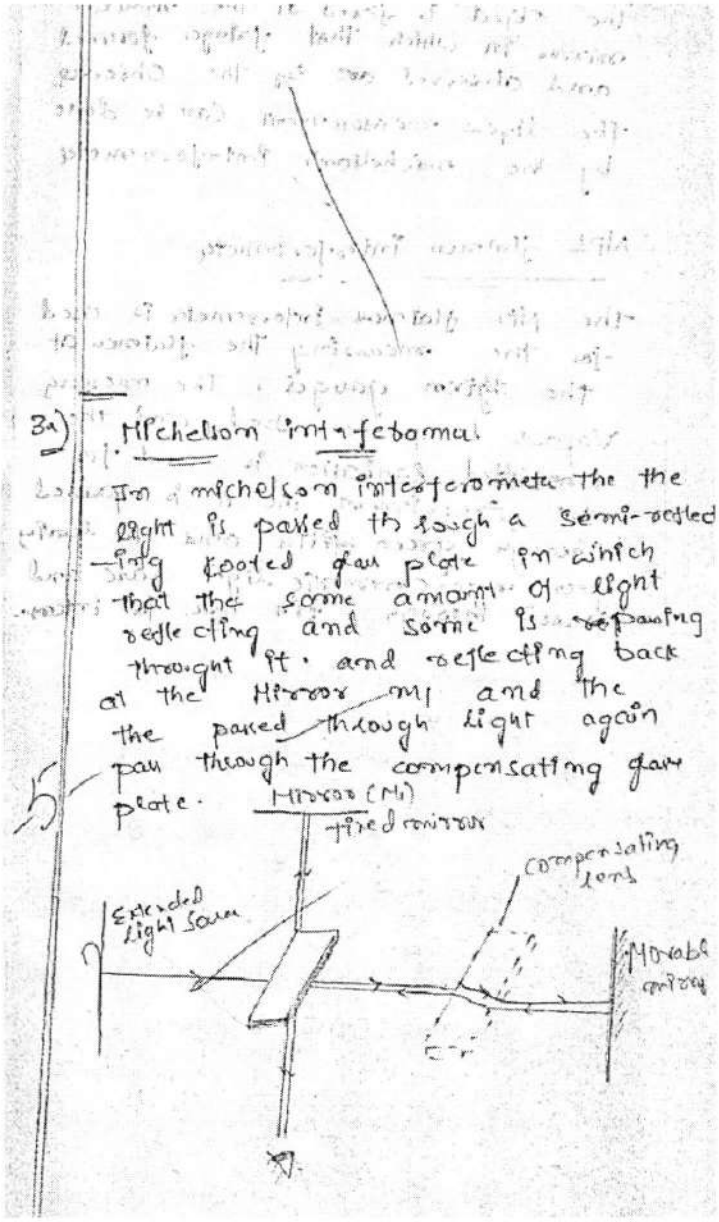
+ 20.0022

Lower Limit =

Higher Limit of GO Gauge = 20 + 0.002

+ 0.002

= 20



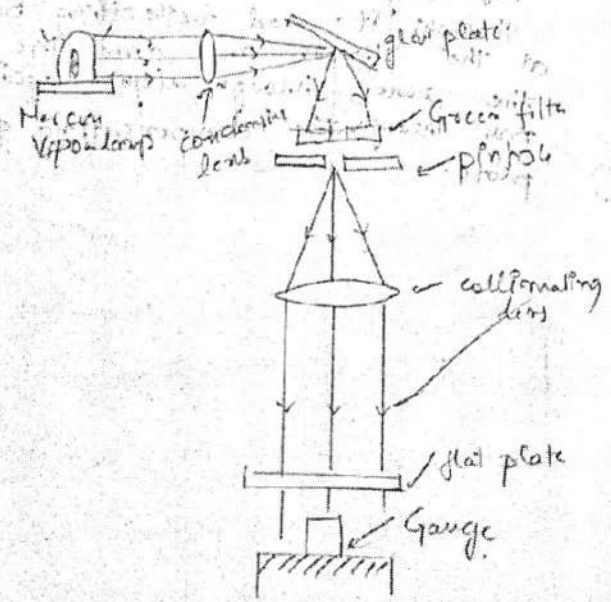
3a) Michelson interferometer

In michelson interferometer the the light is passed through a semi-silvered fixed coated glass plate in which that the some amount of light reflecting and some is passing through it. and reflecting back at the Mirror M1 and the the passed through light again pass through the compensating glass plate.

The Object is fixed at the movable mirror in which that fringes formed and observed are by the Observer the linear measurement can be done by the michelson's interferometer

NPL flatness Interferometer

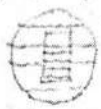
The NPL flatness interferometer is used for the measuring the flatness of the given gauges. The mercury Vapour lamp is used and the emmitted radiation is used for the Experiment the it is passed through green filter and the nearly green monochromatic light rays and passed through pin hole for interfe-



-rence fringes

Then through the collimating lens and then the Gauge and forms a interfe-

(1) If the Gauge is flat

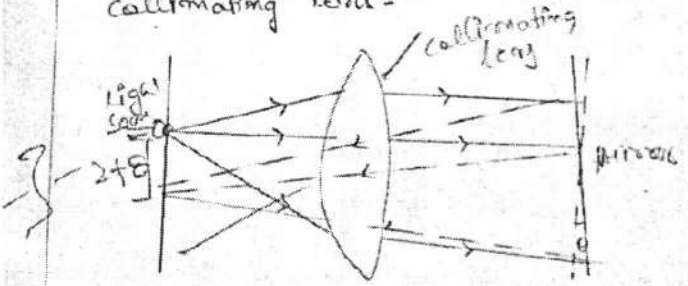


(2) If the Gauge is tapered or uneven

3b) Auto-collimator

principle

The Auto-collimator is used to find the small deviations or inclination It is based on the principle of the the inclined mirror reflect and and formed at focal point of the collimating lens.

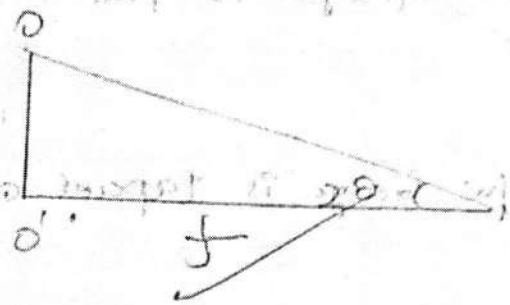


The reflected light from the inclined plate can be found out by the formula,

Let distance = xy'

$\tan 2\theta = \frac{x}{f}$

$\Rightarrow x = 2f\theta$



The Auto-collimate is used to find the small deviations. and the main part of the Auto-collimator is that light source, micrometer and the collimating lens

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ELURU - 534 007

Regd. No.	1	7	B	8	1	A	0	3	A	2		

Class : III / IV Branch : Mechanical Date : 20/1/20

Subject : Metrology Signature of the Invigilator : 20/01/2020

Marks Awarded : 20/30 Signature of the Subject Teacher :

Q. No	1.a	1.b	2.a	2.b	3.a	3.b	Total
Marks	4	3	4	1	3	5	20

1(a) Given ϕ = 50mm

Allowance = 0.035mm

Tolerance on hole = 0.025mm

Tolerance on shaft = 0.017mm

1. Hole Basis system

The lower limit of hole to its basic size = 50mm

Upper limit of shaft = Basic size – min clearance or allowance

= 50 – 0.035

= 49.965mm

Lower limit of shaft = upper limit of shaft – tolerance on shaft

= 49.965 – 0.017

= 49.948 mm

Upper limit of hole = 49.948 + 0.025 = 49.97mm

2. Shaft Basis system

Basic size = 50mm

Lower limit of hole = 49.9773 + 0.025 = 49.9983mm

Upper limit of hole = 49.9983 + 0.025

= 50.023 mm

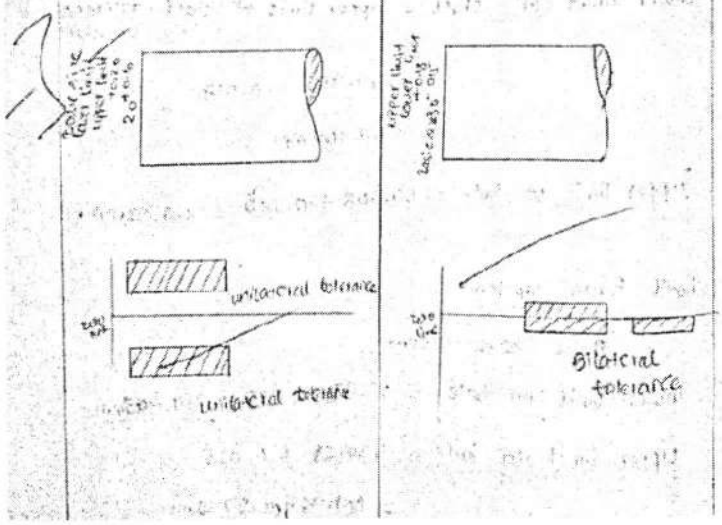
Lower limit of shaft = upper limit of hole – tolerance of shaft

= 50.033 – 0.017

= 49.966mm 50.00 mm

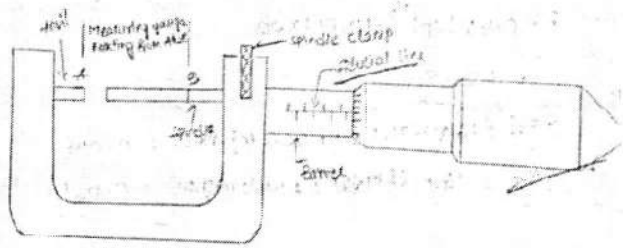
1(b)

Unilateral tolerance	Bilateral tolerance
→ In unilateral tolerance metal is in both limits it on same side	→ In bilateral tolerance the limits are different sides above or below (i.e, either or a nominal size)
→ it can be said to the basic size.	depends on the system tolerance either a unilateral or bilateral
depends on the system tolerance either a unilateral or bilateral	→ Rather than bilateral tolerance unilateral tolerance is used
→ Mostly unilateral tolerance is used	Ex: $20^{+0.12}_{-0.15}$
Ex: $20^{+0.20}_{+0.10}$	Ex: $30^{+0.15}_{-0.12}$
$30^{+0.20}_{-0.00}$	



2(a) External micrometer

External micrometer is used for measuring external surfaces dimensional accuracies etc. upto the accuracy limit of 0.001mm.



The graduation line on barrel consists of the reference line above and on the other or below. It consists of vernier divisions. The line is 0, 5, 10, 15, 20 etc. above value in the reference line in difference is 1mm or of 5, 10 etc. The lower line below is must be between the two successive upper lines.

It is measured from anvil to spindle at the end of face. the micrometer readings are noted.

50 division on micrometer of its circumference. the now 0.001mm. when the micrometer reading is zero. it is closed. If the zero is coincides then the micrometer is t restart.

The number of upper divisions is millimeters and above the refer line. It is having the measuring gauge reading from A to B. the micrometer is along its circumference. for mea the external surfaces external micrometer is used. the frame is made of cast steel. the reading is it consists of 50 divisions each is 1mm.

2(b) Given:

$i = 0.45 D^{1/3} + 0.001 D$

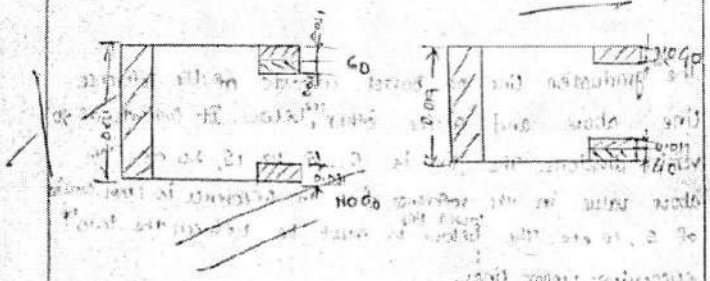
$\Pi 7 = 16i \quad \Pi 8 = 2.5i$

$i = 0.45 (20)^{1/3} + 0.001 \times 20$

$= 1.241$

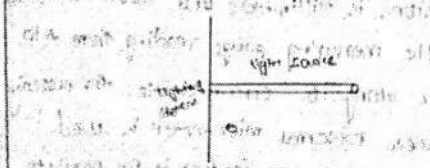
$\Pi 7 = 16 \times 1.241 = 10.856$ microns $= 0.019$

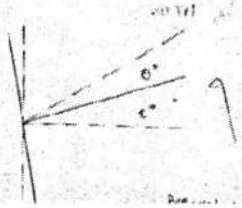
$\Pi 8 = 16 \times 0.5 \times 1.241 = 31.025$ microns $= 0.031$



3(b) Principle and construction of an Auto collimator

Principle of Auto collimator



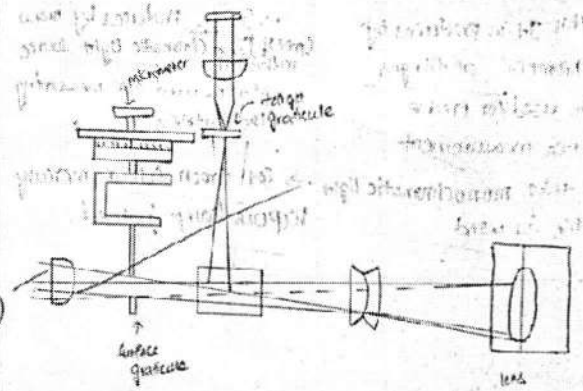


The refracted light ray is used for the auto collimator, when the beam of light ray is passed into the reflected surface it is perpendicular to the ray it come into its original path

Assuming convex lens at point O on the focal plane when the light ray is passed into the reflected surface is perpendicular to the ray its come to its original position the surface is tilted by θ the total angle produced it is deflected by 2θ

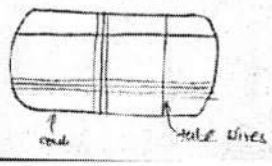
$d = 2\theta f$

Construction of an Auto collimator



The telescope is an instrument at the focal plane the target graticule is not here used it is reverse used as collimator

the optical eyepiece is also used at the same turn by turning at angle of 90°



The tube wire is a [illegible] through the objective. the light is passed to the reflected surface as it is come out of the plane through an objective of the ft. plane.

When the surface is tilted the reflected surface is dispation from its central position. Collimation is used light rays from the beam is come out.

In the microscope also light rays are seen through the lens. the cross wires are produced.

It during calibration the angle of reflection inclination is produced

3(a)

Michelson's Interferometer	Npl flatness interferometer
→ In this It is produces by interference of fringes	→ It is produces by mono chromatic Green radiation
→ It is used for precise distance measurement	→ It is used for measuring the flatness
→ In this monochromatic light source is used	→ In Green colour, mercury vapour lamp is used.

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ELURU - 534 007

Regd. No.	1	7	B	8	1	A	0	3	A	4		

Class : III B.Tech. Branch : MECH Date : 20/01/20.

Subject : Metrology Signature of the Invigilator : 20/01/2020

Marks Awarded : 04/30 Signature of the Subject Teacher :

Q. No	1.a	1.b	2.a	2.b	3.a	3.b	Total
Marks	—	2	Bilateral	—	tolerance		4

1.

b) unilateral tolerance

1. the unilateral which moves only one direction from basic tolerance.

1. the Bilateral tolerance which over and under from basic tolerance.

2. Ex :- +0.002, +0.001 (-0.001, +0.002)

2. Ex :- ±0.02, +0.02, -0.01.

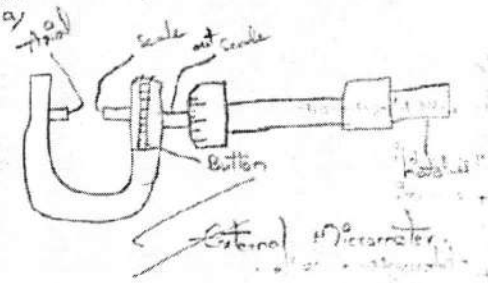
3. the unilateral tolerance is direction under the drilling System it will moves on one direction and it can be segregated as possible.

3. the Bilateral tolerance is under and over the basic tolerance. So, it will not evole under any systems.

* the tolerance is done with combine fit as well and creates unilateral tolerance.	* the tolerance is done with dual fit as well and creates bilateral tolerance.
* the unilateral tolerance which applies only one direction from basic tolerances.	* the bilateral tolerance which is under and above from basic tolerance.
* Ex:- +0.02, +0.01 / +0.01, +0.02	* Ex:- ±0.02, +0.02 / +0.01
* the system which is under the machine is drilling system and moves only in one direction.	* the system is under and above the basic tolerances so denoted Coridor system.
* Totally depends upon the machine work.	* Totally depends upon the basic tolerance.

2.

a)



* the external micrometer works on a basic principle.
* It has axial, Scale, Button, hatcher, etc.....
* the total measurement of the external micrometer is measured through the measuring axial Scale
* when the Screw will rotates according to the object that set to the external micrometer then the following readings will be taken.
* the readings that which are noted on the axial Scale is measured by the axial Scale.
* thus, The working principle of an external micrometer used.

2.

b) Given,

$i = 0.45\sqrt[3]{D} + 0.01D$.

IT7 $= 16i$.

IT8 $= 25i$.

Gauge tolerance = 10%.

D is in mm.

find Gauge type GO → no-GO ?

MID-2

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Regd. No.	1	8	B	8	5	A	0	3	3	2		

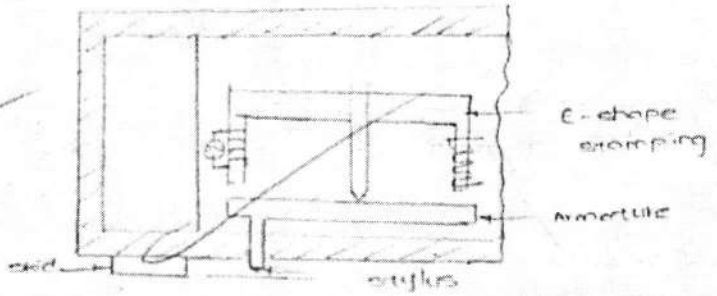
Class III / IV Branch Mechanical Date 14/10/2020

Subject Metrology Signature of the Invigilator

Marks Awarded 30/30 Signature of the Subject Teacher

(a) Taylor-Hobson Talysurf

Total
6 4 4 6 5 5 30



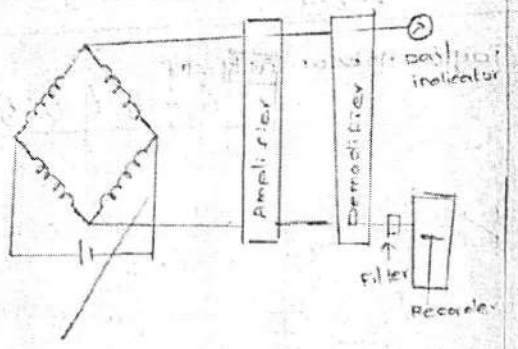
Construction

Taylor-Hobson Talysurf consists of a diamond point stylus attached to a armature. The stylus is move across the tested workpiece. The armature is pivoted at the centere to the E-stamping middle leg. The other two legs are wounded by the wire which carrying a.c current.

Working principle

Taylor-Hobson Talysurf works on the carrier moderating pinciple. The stylus move along the surface to be tested if there any irregularity on the surface the stylus moves upwards and Armature

charges on the one leg (i.e upwards) correspondingly the other leg downwards the variation of air gap b/w the leg changes noted on a recorder. The recorded reading further magnified.



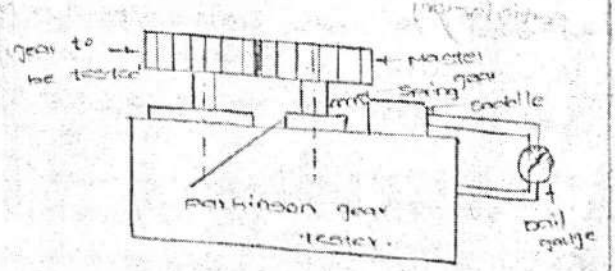
1(b)

Comparator	Measuring Machine
1. comparators are used to check the dimensions with working standards.	1. Measuring M/cs are used to check the dimensions
2. Quick results are obtained	2. Time consuming process.
3. It is used in mass production	3. It is not suitable mass production
4. It is used to check dimensions as well as geometric analysis	4. It is not suitable for geometric analysis.
5. Magnification is provided	5. Magnification is not provided
6. operator skill is not required	6. operator skill is required.

2(a)

2-wire method	3 wire method
1. 2-wires are used on either side of the screw.	1. 3 wires are used. one on one side. two on other side
2. Effective diameter is known quickly	2. Effective diameter is known slowly
3. Limited sizes only.	3. Any sizes can be measured
4. $E = M + P$ $P = S - (R_1 - R_2)$	4. $M = E + Q$ $E = M - [w(1+\operatorname{cosec}\alpha) + \frac{P}{2}\cot\alpha]$

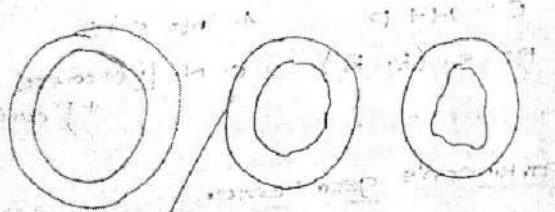
2(b) Parkinson's gear Tester.



Parkinson's gear tester consists of two gears. one is the master gear mounted on a fixed spindle. another is gear to be tested mounted on a movable spindle mounted on sliding saddle. by a force against a spring. and is connected to the dial gauge.

The gears are rated on the spindle in meshing without the measurable clearance. The any changes in the rotating of the gears changes the spring position. The position of spring changes dial gauge reading. The reading is also noted.

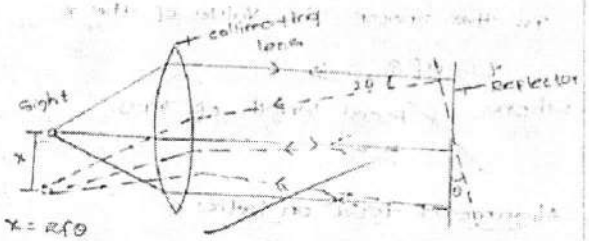
Aslo consists of a recorder of a wax circular sheet which gives the profile of the gear.



Fully satisfactory | Moderate | Unsatisfied

3(a) Auto collimator

Working principle



construction

Auto collimator consists of mainly three parts. (1) Beam splitter (2) Micrometer microscope (3) Lighting unit.

The Beam splitter is place infront of the light source. It splits the light to 45°. The collimating lens are kept b/w the beam splitter and the reflector. t The micrometer microscope is place b/w the beam splitter and light source to see the readings.

Working principle

The light passes through the beam & collimating lens when the reflector makes straight. The reflection of the light reflects backwords the same path.

When the reflector makes the θ deflection. The light passes thrugh lens in a straight way but the reflecton makes the angle 2θ

and also distance of sight, also charges to X.

To the known the value of the X

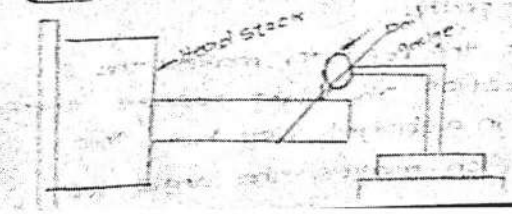
$Y = Rf\theta$

where f = focal length of lens.

2b) Alignment test on lathe

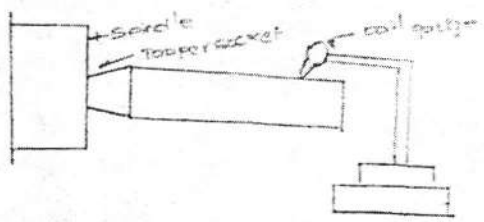
1. level of installation
2. parallelism of the axis of spindle and base.
3. True running of the headstock spindle
4. True running of the a tapper socket in the spindle.
5. perpedicular of carriage to the saddle
6. distance blw the centers.
7. Axial pitch of the lead screw
8.

True running of the head stock spindle



The rotation of the of head stock spindle and axis of the spindle should be same. If it is not true. the jobs performed are get eccentricity. the to perform these test hold a bar in head stock and put a dail gauge touches the surface. and a rotate the work piece

True running of the taper socket in the spindle



The tapper socked is holded in the spindle and rotate. The axis of the tapper socket and the spindle shaild be same. otherwise concentric jobs are obtained.

To perform this test hold the tapper socket in spindle and place the dail gauge contact to the work piece and rotate. move the dial gauge across the tapper socket.

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DEPARTMENT OF MECHANICAL ENGINEERING

SIR C.R.REDDY COLLEGE OF ENGINEERING

ELURU - 534 007

Regd. No.	1	7	B	8	1	A	0	3	4	8		

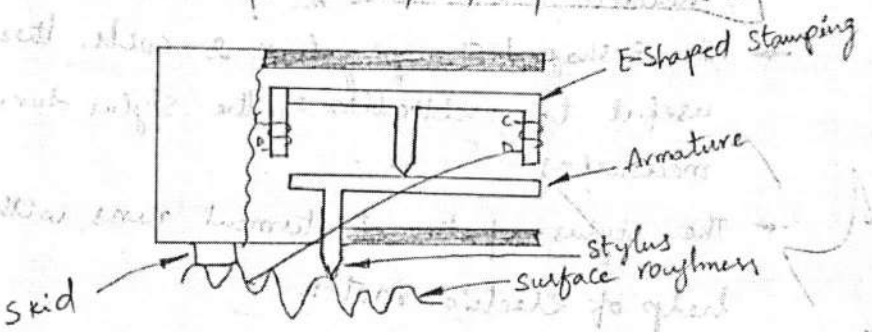
Class : III/IV B.Tech. Mech. Branch : Mechanical Date : 14/10/2020

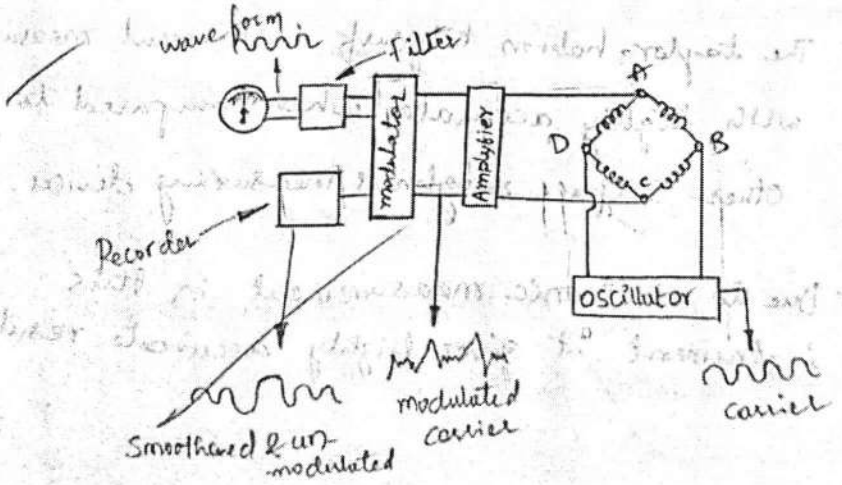
Subject : Metrology Signature of the Invigilator :

Marks Awarded : 17/30 Signature of the Subject Teacher :

1) a) Taylor-Hobson Taly surf :-

5444--17





Electric mean

Construction:-

→ The Taylor-hobson talysurf has a skid and stylus instrument.

- The deflection in the stylus due to the surface roughness of a profile is converted into electrical energy and the air gap between the armature and E-shaped stamping causes measuring of surface roughness.

Construction :-

- The instrument reads the measurement with the stylus headed to its end.
- The stylus has a radius of 0.002 mm diamond headed
- The E-shaped stamping has 2-coils. These are useful to oscillation of the stylus during measuring.
- The stylus of the instrument runs with the help of electric motor.
- The taylor-hobson talysurf instrument measures with highly accurate when compared to other surface roughness measuring devices.
- Due to electronic measurement in this instrument it gives highly accurate results.

1) b)

Comparator	Measuring machine (Gauge)
1) Comparator is compares the measurement of the workpiece with respect to the actual measurement of the workpiece	1) Measuring machine only measures the measurement of actual workpiece.
2) Magnification System is required for the Comparator	2) There is no requirement of magnification system
3) Mass production is possible	3) Mass production is not possible
4) There is no requirement of skilled laobar	4) Skilled labours are required for the accurate measurement.

2) a) Two wire method :-

1) Two wires (or) rods of same diameter are used in this method.
2) Less accurate results are obtained from this method
3) In this measurement we used diameter measuring device.
4) Effective diameter $E = T + K$

where, T = Diameter under the rods

K = Constant depends on diameter of the wire

Three wire method :-

1) Three wires are used in this method.
2) Highly accurate results are obtained from Three wire method.
3) In this method we use micrometer
4) Effective diameter

$$E = N - \left[d\left(1+\operatorname{cosec}\frac{\alpha}{2}\right) - \frac{P}{2}\cot\frac{\alpha}{2}\right]$$

where, N = Diameter over the rods
d = diameter of actual workpiece.
α = angle between the rods.

2)
b) Parkinson's gear tester is used to measure the accuracy of the workpieces with a respect to the practical measurements.

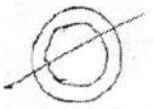
← The parameters that are checked with the help of Parkinson's gear tester are three types

i)

Highly accurate and smoothened profile

← The highly accurate and smoothened is the good profile to use in the working condition

ii)



Moderately Satisfied profile

← In moderately satisfied good gear profile there is less accuracy and smoothness when be compared to the highly satisfied profile.

iii)

Unsatisfied profile

← In this unsatisfied profile there, no accuracy and also smoothness when compared to the other two types of the profiles.

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ELURU - 534 007

Regd. No.	1	7	B	8	1	A	0	3	A	6		

Class : III [IV] B.tech Branch : Mechanical Date : 14/10/20

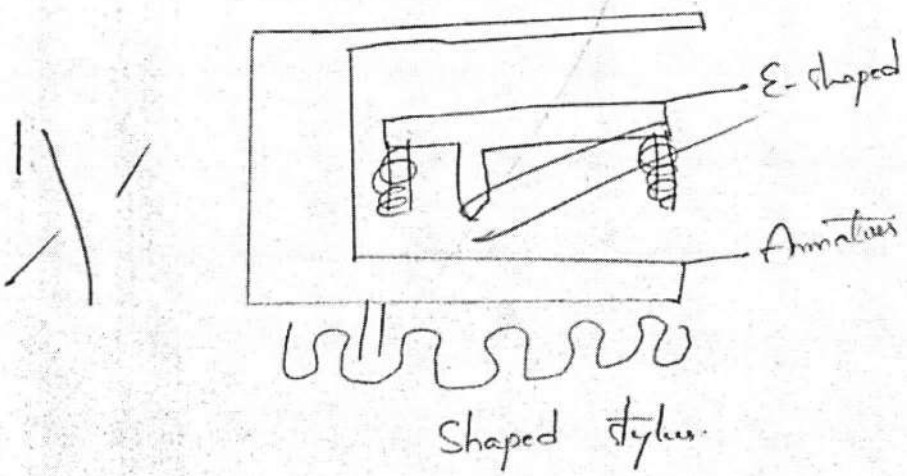
Subject : Metrology Signature of the Invigilator : E.R.S

Marks Awarded : 04/30 Signature of the Subject Teacher :

1. a) the Construction and working of Taylor-Hobson Talysurf the between Comparator and measuring machine. Profile of a gear tooth Can be checked by Profile projector.

→ Slip guages are made of following material stainless steel Aluminum Cast iron and Tungsten Carbide.

→ what is the instrument to check whether the work-piece is properly Centred in a four jaw chuck.



b) Comparator

- Atmospheric pressure, molecular attraction and flow.
- Gear teeth together is used for Comparator
- Analyze the parameters that are checked
- Comparator method
- This process occurs in strength material such as iron

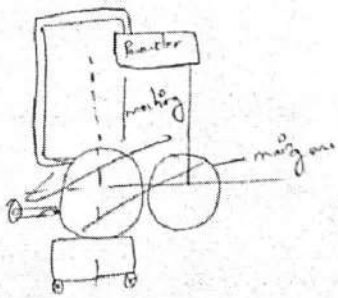
Measuring Machine

- Roundness of Cylindrical work, Surface roughness and Taper on a job.
- Illustrate the Construction and working principle.
- Distinguish between these one and these using method.
- Measuring machine method
- This process occurs in loose materials such as Cement, Sand.

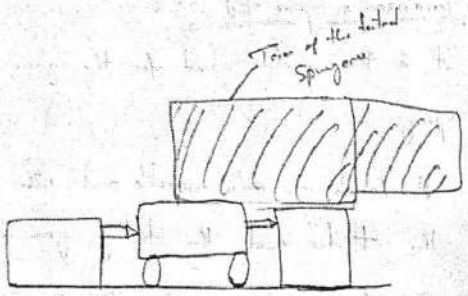
2) Parkinson's Gear Tester :-

b/y It is the machine used for the gears help of spring.

- It Consists of main Spindle and left the hold the Header and the testing gear is placed
- With help of the Spring pressure the working gear is operated.
- With the help of rolling all Errors Can't be checked
- If there are any Errors the slider motion and there will be a deflection in the gears.



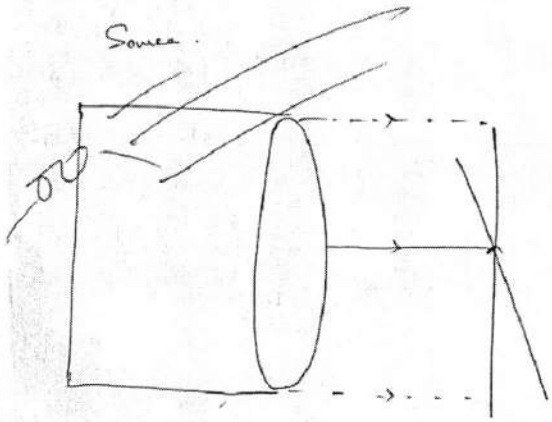
8 a)



* Testing gears with the main Spindle.
* The gear is placed on the slider which is to be tested and main gear fixed on the Spindle.

3,

9 a) Auto collimator :- It is the device which is used to measure the angles with the help of the light source.



SIR C.R. REDDY COLLEGE OF ENGINEERING

Eluru-534007, West Godavari Dist., A.P., INDIA

(Approved by AICTE, New Delhi & Permanently affiliated to JNTU, KAKINADA)

Phone no: 08812 – 230840, 2300656 Fax: 08812 – 224193 Visit us at http://www.sircrrengg.ac.in

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY RESULT ANALYSIS

Academic Year: 2019-20

Name of the Program:			
Course: **METROLOGY**			Course Code: **R1632031**
Year: **III**	Semester: **II**		Section: **A**
Course Handler: Chandra Rao. Ch			Designation: Assistant Professor

No. of students appeared	No. of students passed	No. of students failed	Pass %
68	**67**	**01**	**98.52**

GRADE	No of Students
O	0
S	1
A	11
B	34
C	14
D	7
F	1
Total	**68**

Signature of faculty

SIR C R REDDY COLLEGE OF ENGINEERING, ELURU-7

DEPT. OF ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE FILE CHECK LIST

PART-I

S. No	Title
1	Title page
2	Certificate
3	Institute's Vision & Mission
4	Department's Vision & Mission
5	PEO's, PO's, and PSO's
6	Syllabus Copy
7	Course Description
8	Class Time Table
9	Individual Time Tables
10	Academic calendar
11	Student Roll List
12	List of CO's and CO-PO/PSO Mapping with Justifications
13	Model lesson plan
14	Module Implementation Plan
15	Internal Questions mapping with CO's
16	Assignment questions mapping with CO's
17	Quality measurement sheets

PART-II

S.NO	Title
1.	University Question papers of previous years with solutions
2.	Internal Question Papers with Solutions
3.	Assignment question papers with solutions
4.	Internal Evaluation Procedure
5.	Consolidated Internal Marks
6.	Lecture notes/ Course Handouts
7.	Unit-Wise question bank

Sir C.R. Reddy College of Engineering, Eluru.

Department of Electronics & Communication Engineering.

	Course File
	Class: IV/IV **Semester**: I **Batch:**2017-21 **Regulation:** R16

Name of the course	:	**System Design through Verilog**
Course Code	:	**415**
Name of the Dept.	:	**Electronics & Communication Engineering**
Module Coordinator	:	**Dr.P.H.S.Tejomurthy**
Course Coordinator	:	**K.Radha**
Name of the Faculty	:	**K.Radha, P.Hareesh**
Academic Year	:	**2020-2021**
Class	:	**IV/IV B.Tech**

1. (Radha)
2. P. Hareesh

Signature of the Course Coordinator

Signature of the staff

Signature of the Module Coordinator

HOD-ECE

Head of the Department
Electronics & Communication Engg.
Sir C.R.R.College of Engineering
Eluru - 534 007

Sir C.R. Reddy College of Engineering, Eluru.

Department of Electronics & Communication Engineering.

	Course File
	Class: IV/IV **Semester**: I **Batch:**2017-21 **Regulation:** R16

CERTIFICATE OF AUTHENTICATION

This is to certify that, **K.Radha, P.Hareesh,** of **Electronics and Communications Engineering** Department has prepared the course material for **System Design through Verilog,** Code:**415** of **JNTUK** for the academic year **2020-21**. The contents of this course/teaching module have not been reproduced elsewhere in any books or journals.

This is the sole property of SIR C.R.REDDY COLLEGE OF ENGINEERING, ELURU to be referred by staff and students.

Name of the Faculty: 1.K.Radha, Assistant Professor, Dept. of ECE.

2. P.Hareesh, Assistant Professor, Dept. of ECE.

Course Coordinator : K.Radha, Assistant Professor, Dept. of ECE.

Module Coordinator: Dr. P.H.S.Tejomurthy, Professor, Dept. of ECE.

1. K.Radha
2. P.Hareesh

Signature of the Course Coordinator

Signature of the staff

P H S T

Signature of the Module Coordinator

HOD-ECE

Head of the Department
Electronics & Communication Engg.
Sir C.R.R.College of Engineering
Eluru - 534 007

Sir C.R. Reddy College of Engineering, Eluru.

Department of Electronics & Communication Engineering.

	Course File
	Class: IV/IV **Semester**: I **Batch:**2017-21 **Regulation:** R16

INSTITUTE VISION

To emerge as a premier institution in the field of technical education and research in the state and as a home for holistic development of students and contribute to the advancement of society and the region.

INSTITUTE MISSION

To provide high quality technical education through a creative balance of academic and industry oriented learning; to create an inspiring environment of scholarship and research; to instill high levels of academic and professional discipline; and to establish standards that inculcate ethical and moral values that contribute to growth in career and development of society in general.

Sir C.R. Reddy College of Engineering, Eluru.

Department of Electronics & Communication Engineering.

	Course File
	Class: IV/IV **Semester**: I **Batch:**2017-21 **Regulation:** R16

DEPARTMENT VISION

To be a premier department in the region that nurtures individuals for acquisition of knowledge and skills with research orientation which suits the local and global needs of industry and society in the field of Electronics and Communication Engineering.

DEPARTMENT MISSION

To impart quality education and encourage research with an emphasis on application and innovation; to cater the emerging societal needs through all-round development of students; to enable individuals face the global competition; to inculcate the importance of ethical and moral values in students.

Sir C.R. Reddy College of Engineering, Eluru.
Department of Electronics & Communication Engineering.

	COURSE FILE
	CLASS: IV/IV B.Tech (ECE) | **Academic Year :** 2020-21
	Course title with Code: System Design through Verilog-415
	Name of the faculty :K.Radha, P.Hareesh

Program Educational Objectives:

PEO1: Develop a solid foundation in mathematics and sciences to solve electronics and communication engineering problems.

PEO2: Apply core engineering concepts to develop novel products and solutions demanded by modern industry.

PEO3: Pursue higher studies, research & development in science & technology and keep abreast of latest technological developments.

PEO4: Inculcate professional and ethical attitude, effective communication skills, Team spirit & leadership qualities.

PEO5: Contribute to the needs of the society in solving technical problems using Electronics and Communication engineering principles, tools and practices

Program Outcomes:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, society, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in society and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO-Program Specific Outcomes

A graduate of the Electronics and Communication Engineering Program will be able:

PSO1: Apply domain specific knowledge for the design and analysis of VLSI and Communication System applications.

PSO2: Demonstrate technical competency by developing hardware and software applications in the fields of IOT, Embedded and related systems.

Sir C.R. Reddy College of Engineering, Eluru.
Department of Electronics & Communication Engineering.

	COURSE FILE
	CLASS: IV/IV B.Tech (ECE) | **Academic Year :** 2020-21
	Course title with Code: System Design through Verilog-415
	Name of the faculty :K.Radha, P.Hareesh

Detailed Syllabus

SYSTEMDESIGNTHROUGH VERILOG

(Elective-I)

UNIT-I

INTRODUCTION TOVERILOG:

Verilog as HDL, Levels of design description, concurrency ,simulation and synthesis, functional verification, system tasks, programming language interface(PLI), module, simulation and synthesis tools, test benches.

LANGUAGECONSTRUCTSANDCONVENTIONS:

Introduction, keywords, identifiers, whitespace characters, comments, numbers, strings, logic values, data types, scalars and vectors, parameters, memory, operators, system tasks.

UNIT-II

GATE LEVEL MODELLING:

Introduction, AND gate primitive, module structure, other gate primitives, illustrative examples, tri state gates, array of instances of primitives, design of Flip flops with gate primitives, delays, strengths and contention resolution, net types, design of basic circuits.

UNIT-III

BEHAVIORAL MODELLING:

Introduction, operations and assignments, functional Bifurcation, initial construct, always construct, examples ,assignments with delays, wait construct, multiple always blocks, designs at behavioral level, blocking and non-blocking assignments, the case statement, simulation flow, if and if else constructs, assign-De assign construct, repeat construct, FOR loop, the disable construct, While loop, Forever loop, parallel blocks, force-release construct, event.

UNIT-IV

DATAFLOW LEVELANDSWITCH LEVELMODELLING:

Introduction, continuous assignment structures, delays and continuous assignments, assignment to vectors, basictransistor switches, CMOS switch, Bidirectional gates and time delays with switch primitives, instantiations with strengths and delays, strength contention with tri reg nets.

UNIT-V

SYNTHSISOFCOMBINATIONALANDSEQUENTIALLOGICUSINGVERILOG: Synthesisof

Combinational logic: Net list of structured primitives, a set of continuous assignment statements and level sensitive cyclic behavior with examples, Synthesis of priority structures, Exploiting logic don't care conditions. Synthesis of sequential logic with latches: Accidental synthesis of latches and Intentional synthesis of latches, Synthesis of sequential logic with flip-flops, Synthesis of explicit state machines.

UNIT-VI

VERILOGMODELS:

Static RAM Memory, A simplified 486 Bus Model, Interfacing Memory to a Microprocessor Bus, UART Design and Design of Micro controller CPU.

TEXT BOOKS:

1. Design through Verilog HDL–T.R.Padmanabhan and B.Bala Tripura Sundari, WSE, IEEE Press,2004.
2. Advanced Digital Design with Verilog HDL–Michael D. Ciletti, PHI, 2005.

REFERENCES:

1. FundamentalsofLogicDesignwithVerilog–Stephen.BrownandZvonkoVranesic,TMH,2005.
2. A Verilog Primier–J.Bhasker, BSP,200

Sir C.R. Reddy College of Engineering, Eluru.

Department of Electronics & Communication Engineering.

	COURSE FILE
	CLASS: IV/IV B.Tech (ECE) | **Academic Year :** 2020-21
	Course title with Code: System Design through Verilog-415
	Name of the faculty :K.Radha, P.Hareesh

COURSE DESCRIPTION

Subject	:	**System Design through Verilog**
Subject code	:	**ECE 415**
Credits	:	**3**
Branch	:	**Electronics & Communication Engineering**

1. Course description:

A comprehensive resource on Verilog HDL for beginners and experts large and complicated digital circuits can be incorporated into hardware by using Verilog, a hardware description language (HDL).

2. Objective:

This course will enable students to

1. Understand the concepts of Verilog Language
2. Design the digital systems as an activity in a larger systems design context.
3. Study the design and operation of semiconductor memories frequently used in application specific digital system.
4. Inspect how effectively ICs are embedded in package and assembled in PCBs for different application.
5. Design and diagnosis of processors and I/O controllers used in embedded systems.

3. Prerequisite:

Knowledge of subjects like Digital Electronics and Verilog HDL is desirable.

SIR C. R. REDDY COLLEGE OF ENGINEERING, ELURU-07
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
IV/IV BE (ECE) - I Sem, Time Table, Sec - A, A.Y 2020-21

Class Teacher : Mr. V. Surendra Babu

LH-25

Dt: 30/10/2020
w.e.f: 02/11/2020

Periods / Theory	1 9.00-09.50	2 9.50-10.40		3 11.00-11.50	4 11.50-12.40		5 01.40-02.30	6 02.30-03.20	7 03.20-04.10	8 04.10-05.00
MON	CN	MEO / DSP LAB					ES	RS	DIP	OC
TUE	SDTV	CN	BREAK	RS	DIP	LUNCH	OC	CN	SDTV	ES
WED	ES	RS		DIP	OC		CN	MEO / DSP LAB		
THU	OC	MEO / DSP LAB					CN	DIP	ES	SDTV
FRI	RS	DIP		CN	SDTV		RS	SDTV	OC	ES
SAT	OC	SDTV		RS	CN					

Examinations in-charge: Mrs. K. Radha

Attendence in-charge: Mrs. N. Lavanya

Code	Subject	Staff
1	Radar Systems	Mrs G. Srilatha
2	Digital Image Processing	Mr. V. Surendra Babu
3	Computer Networks	Mrs. N. Lavanya
4	Optical Communications	Dr. T. Venkateswara Rao
5	System Design Through Verilog (E-I)	Mrs. K. Radha
6	Embedded System (E-II)	Mr. R. Trinath
7	Microwave Engg. & Opticals Lab	GS / RT
8	Digital Image Processing Lab	DAK / NL

Time Table I/C

30/10
HOD-ECE
Head of the Department
Electronics & Communication Engg.
Sir C.R.R. College of Engineering
Eluru - 534 007

Principal
SIR C.R.R. COLLEGE OF ENGINEERING
ELURU -534 007
PRINCIPAL

Vision:
To be a premier department that nurtures individuals for acquisition of knowledge with research orientation which suits the local and global needs of industry and society in the field of Electronics and Communication Engineering.

Mission:
M1. To impart quality education and encourage research with an emphasis on application and innovation
M2. To cater to the emerging societal needs through all-round development of students.
M3. To enable individuals face the global competition.
M4. To inculcate the importance of ethical and moral values in students.

SIR C. R. REDDY COLLEGE OF ENGINEERING, ELURU-07
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
IV/IV BE (ECE) - I Sem, Time Table, Sec - B, A.Y 2020-21

Class Teacher : Mrs. K. Lavanya

LH-26

Dt: 30/10/2020
w.e.f: 02/11/2020

Periods / Theory	1 9.00-09.50	2 9.50-10.40	BREAK	3 11.00-11.50	4 11.50-12-40	LUNCH	5 01.40-02.30	6 02.30-03.20	7 03.20-04.10	8 04.10-05.00
MON	RS	DIP		SDTV	CN		OC	DIP	ES	OC
TUE	OC	MEO / DSP LAB					DIP	CN	RS	SDTV
WED	CN	SDTV		DIP	RS		SDTV	OC	ES	ES
THU	SDTV	ES		CN	DIP		RS	MEO / DSP LAB		
FRI	OC	MEO / DSP LAB					CN	DIP	ES	RS
SAT	ES	RS		SDTV	CN					

Examinations in-charge: Mr. K. Miranji **Attendence in-charge: Mrs. G. Srilatha**

Code	Subject	Staff
1	Radar Systems	Mrs G. Srilatha
2	Digital Image Processing	Dr. P. H. S. Tejomurthy
3	Computer Networks	Mrs. K. Lavanya
4	Optical Communications	Mr. K. Lakshminarayana
5	System Design Through Verilog (E-I)	Mr. P. Hareesh
6	Embedded System (E-II)	Mr. K. Miranji
7	Microwave Engg. & Opticals Lab	KLN / GS
8	Digital Image Processing Lab	Dr TM / PH

Time Table I/C

HOD-ECE
Head of the Department
Electronics & Communication Engg.
Sir C.R.R.College of Engineering
Eluru - 534 007

Principal
SIR C.R.R. COLLEGE OF ENGINEERING
ELURU -534 007
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SIR C. R. REDDY COLLEGE OF ENGINEERING, ELURU-07
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
IV/IV BE (ECE) - I Sem, Time Table, Sec - C, A.Y 2020-21

Class Teacher : Dr. I. Hemalatha

Dt: 30/10/2020
w.e.f: 02/11/2020

LH-27

Periods / Theory	1 9.00-09.50	2 9.50-10.40	BREAK	3 11.00-11.50	4 11.50-12-40	LUNCH	5 01.40-02.30	6 02.30-03.20	7 03.20-04.10	8 04.10-05.00
MON	DIP	OC		RS	SDTV		CN	MEO / DSP LAB		
TUE	RS	DIP		ES	SDTV		OC	CN	RS	DIP
WED	OC	MEO / DSP LAB					ES	DIP	SDTV	CN
THU	SDTV	RS		CN	OC		ES	SDTV	RS	ES
FRI	RS	ES		CN	DIP		OC	MEO / DSP LAB		
SAT	ES	OC		DIP	SDTV					

Examinations in-charge: Mr. R. Trinath

Attendence in-charge: Mrs. P. Soumithri

Code	Subject	Staff
1	Radar Systems	Mrs P. Soumithri
2	Digital Image Processing	Mr. V. Surendra Babu
3	Computer Networks	Dr. M. Ravikumar
4	Optical Communications	Mr. K. Lakshminarayana
5	System Design Through Verilog (E-I)	Mrs. K. Radha — 6
6	Embedded System (E-II)	Mr. R. Trinath
7	Microwave Engg. & Opticals Lab	PS / NSW
8	Digital Image Processing Lab	Dr IH / KL

Time Table I/C

HOD-ECE
Head of the Department
Dept. of Electronics & Communication Engg.
Sir C.R.R.College of Engineering
ELURU - 534 007

Principal
SIR C.R.R. COLLEGE OF ENGINEERING
ELURU -534 007
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M3. To enable individuals face the global competition.
M4. To inculcate the importance of ethical and moral values in students.

Website: www.jntuk.edu.in
Email: dap@jntuk.edu.in

Phone: 0884-2300991
Mobile: 8008631555

(11)

Directorate of Academic Planning

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
KAKINADA-533003, Andhra Pradesh, INDIA
(Established by AP Government Act No. 30 of 2008)

Lr. No. 01-08/ JNTUK/DAP/AC/B. Tech-B. Pharmacy/II-III-IV Year/2020-21 *Date: 29-12-2020*

Dr. K. Srinivasa Rao,
Director, Academic Planning
JNTUK, Kakinada

To
All the Principals of Affiliated Colleges,
JNTUK, Kakinada.

Academic Calendar for II, III and IV - B. Tech & B. Pharmacy
Academic year 2020-21

I SEMESTER			
Description	**From**	**To**	**Weeks**
Commencement of Class Work	**02.11.2020**		
I Unit of Instruction	02.11.2020	19.12.2020	7W
II Unit of Instructions	21.12.2020	23.01.2021	5W
I Mid Examinations	25.01.2021	30.01.2021	1W
II Unit of Instructions(Continued)	01.02.2021	20.02.2021	3W
II Mid Examinations	22.02.2021	27.02.2021	1W
Preparation & Practicals	01.03.2021	06.03.2021	1W
End Examinations	08.03.2021	20.03.2021	2W
Commencement of II Semester Class Work	22.03.2021		
II SEMESTER			
I Unit of Instructions	22.03.2021	08.05.2021	7W
I Mid Examinations	0.05.2021	12.05.2021	1/2W
II Unit of Instructions	3.05.2021	30.06.2021	7W
II Mid Examinations	01.07.2021	03.07.2021	1/2W
Preparation & Practicals	05.07.2021	10.07.2021	1W
End Examinations	2.07.2021	24.07.2021	2W
Commencement of next Year Class Work			
Note: Calendar is prepared with 8 hrs/day hence 7 weeks per instruction period			

Director Academic Planning

Director
Academic Planning
JNTUK Kakinada

Copy to the Secretary to the Hon'ble Vice Chancellor, JNTUK
Copy to Rector, JNTUK
Copy to Registrar, JNTUK
Copy to Director Academic Audit, JNTUK
Copy to Director of Evaluation, JNTUK

K V R

Examination-In-Charge
SIR C.R.R.College of Engineering
ELURU-534 007

04/01/2021

Sir C.R. Reddy College of Engineering, Eluru.
Department of Electronics & Communication Engineering.

COURSE FILE

CLASS: IV/IV B.Tech (ECE) | **Academic Year :** 2020-21

Course title with Code: System Design through Verilog-415

Name of the faculty :K.Radha, P.Hareesh

Course Outcomes: After completion of the course student must be able to:

CO1:interpret language construct and conventions in Verilog HDL

CO2: construct various basic digital modules using Verilog HDL

CO3: analyze the synthesis of various combinational and Sequential circuits

CO4: identify various verilog models like memory, microprocessor and microcontroller, bus models etc.

CO – PO mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2		-	-	-	-	-	-	-	-	-	-
CO-2	3		-	-	-	-	-	-	-	-	-	-
CO-3	-	2	-	-	-	-	-	-	-	-	-	-
CO-4	-	2	-	-	-	-	-	-	-	-	-	-
Avg	2.5	2	-	-	-	-	-	-	-	-	-	-

CO – PSO mapping:

CO/PSO	PSO1	PSO2
CO-1	2	
CO-2	2	1
CO-3	2	1
CO-4	2	1
Avg	2	1

CO – PO mapping Justification:

CO1	Fundamentals of engineering is required to interpret language constructs and conventions in verilog(PO1)
CO2	Knowledge on engineering fundamental concepts is useful in the design of combinational and sequential digital circuits(PO1)
CO3	One must have strong knowledge on problem analytics to perform synthesis of combinational and sequential digital circuits(PO2)
CO4	One must have a strong research literature and problem analytics to perform synthesis of various verilog models like memory, microprocessor and microcontroller, bus models etc.(PO2)

CO – PSO mapping Justification:

CO1	Knowledge of lanquage constructs and conventions in verilog is required to perform the design of VLSI systems(PSO1)
CO2	Several combinational and sequential circuits are to be designed to develop applications in VLSI (PSO1) and embedded (PSO2) subsystems
CO3	Knowledge on synthesis is useful to perform the analysis and design of VLSI(PSO1) and embedded applications (PSO2).
CO4	Several verilog models are required to build VLSI(PSO1),IOT and embedded applications(PSO2)

Course Coordinator

Module Coordinator

HOD-ECE

Head of the Department
Electronics & Communication Engg.
Sir C.R.R.College of Engineering
Eluru - 534 007

Sir C.R. Reddy College of Engineering, Eluru.
Department of Electronics & Communication Engineering.

	COURSE FILE
	CLASS: IV/IV B.Tech (ECE) | **Academic Year :** 2020-21
	Course title with Code: System Design through Verilog-415
	Name of the faculty :K.Radha, P.Hareesh

Model Lesson Plan

No.of classes required : 80

No.of classes conducted : 95 (A - SECTION)

No.of classes conducted : 93 (B - SECTION)

No.of classes conducted : 96 (C - SECTION)

Schedule Plan

S.No	Description	Total No. of Periods
1	**Introduction to verilog, Language constructs & conventions**	13
2	**Gate Level modelling**	17
3	**Behavioral Modelling**	12
4	**Data Flow and Switch Level Modelling**	13
5	**Synthesis of Combinational & sequential logic using Verilog**	12
6	**Verilog Models**	13
Total Classes		**80**

Q.No	Marks	CO	PO	PSO	BTL	% of marks
1a	10/30	CO1	PO1	PSO1	L1	35 %
1b						
2a	10/30	CO2	PO1	PSO1,PSO2	L2	30 %
2b						
3a	10/30	CO1, CO2	PO1	PSO1,PSO2	L2	35 %
3b						

1.
2.

Course Handler | Course co-ordinator | Module coordinator

Q.No	Marks	CO	PO	PSO	BTL	% of marks
1a	10/30	CO2	PO1	PSO1,PSO2	L1	30 %
1b						
2a	10/30	CO3	PO2	PSO1,PSO2	L2	35 %
2b						
3a	10/30	CO4	PO2	PSO1,PSO2	L2	35 %
3b						

1.
2.

Course Handler | Course co-ordinator | Module coordinator

Consolidated Course End Survey

Subject: SDTV	**Code:415**	
Year : IV/IV	**Sem: II**	**Branch: ECE**

CES Questions:

1 Interpret language construct and conventions in Verilog HDL.

2.Construct various basic digital modules using Verilog HDL

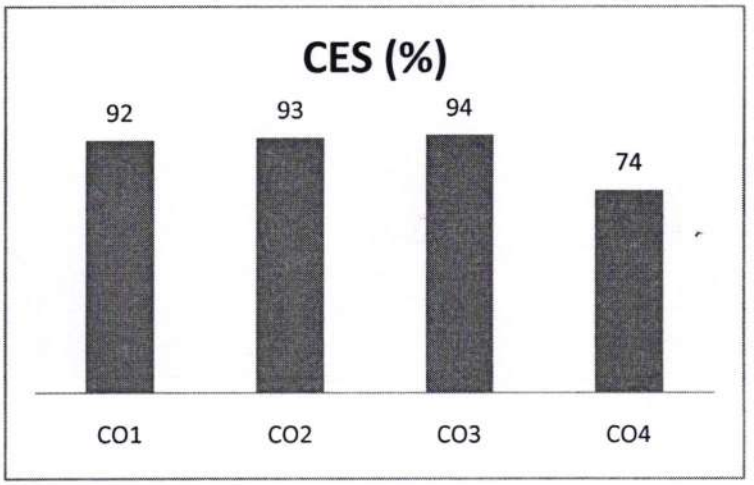
3.Analyze the synthesis of various combinational and Sequential circuits

4Identify various verilog models like memory, microprocessor and microcontroller, bus models etc.

Note: To fill the columns a scale from 1 to 5 is used

1- Poor **2**-Satisfactory **3**-Average **4**-Good **5**-Excellent

SECTION-A,B &C



HOD-ECE

Head of the Department
Electronics & Communication Engg
Sir C.R.R.College of Engineering
Eluru - 534 007

Sir C.R. Reddy College of Engineering, Eluru.
Department of Electronics & Communication Engineering.

Subject: System Design through Verilog (415)

CO Attainment:

Course Outcomes	CO1	CO2	CO3	CO4
Overall CO attainment	2.59	2.59	2.83	2.63
Target for A.Y: 2019-2020	2.1	2.1	2.1	2.1
Target Met or Not Met (M/NM)	M	M	M	M
Target for next year 2020-2021	2.2	2.2	2.2	2.2

PO Attainment:

PO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Overall PO attainment	2.59	2.73	-	-	-	-	-	-	-	-	-	-	2.66	2.69

faculty course coordinator module coordinator

1. K R Reddy. C Reddy.. P H S PH'PHST

2. PH P. Hareesh KR

3. K R C Reddy..

HOD-ECE

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Sir C.R. Reddy College of Engineering, Eluru.

Department of Electronics & Communication Engineering.

	COURSE FILE
CLASS: IV/IV B.Tech (ECE)	**Academic Year :** 2020-21
Course title with Code: System design through verilog-415	
Name of the faculty :K.RADHA, P.HAREESH	

INTERNAL EXAM EVALUTION PROCEDURE

In theory subjects marks for internal evaluation are 30.

Students are evaluated for internal marks based on their performance in

1) I & II Internal Examinations. 15 Marks
2) Assignment conducted 5 Marks
3) Quiz Conducted 10Marks

Internal Examination: Two descriptive tests are conducted which are called as internal examination in each semester for each subject. Each test is conducted for 30 marks in 90 minutes duration. Question paper consists of three questions without internal choice. All questions should be answered. Each question carries 10 marks. After evaluation of internal examination these marks will be reduced to 15 marks.

Assignment: Two Assignments are conducted in each semester for each course. Each assignment is evaluated for 5 marks. First assignment marks (5M) will be added to first internal (15M) and second assignment marks (5M) will be added to second internal (5M).

Quiz: Two objective tests are conducted by university in online which are called as quiz examination in each semester for each subject. Each test is conducted for 20 marks in 20 minutes duration. Question paper consists of 20 multiple choice questions. Each question carries 1 marks. After evaluation of quiz examination marks will be reduced to 10 marks. These marks will be added to assignment marks and internal examination marks.

First Internal Marks (30M) = First mid marks (reduced to 15M)+ First Assignment marks(5M)+ First Quiz marks(10M)

Second Internal Marks(30M) = Second mid marks (reduced to 15M)+ Second Assignment marks(5M)+ Second Quiz marks(10M)

Total Internal Marks (30M) will be best performed one is given weightage of 80% and 20% for another. It will be decided by university.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

Second PDF For IV B.Tech I Semester Internal Marks : B8

College : C.R REDDY COLLEGE OF ENGINEERING:B8

Date:30-04-2021

Subcode:R164104C

Subject:System Design through Verilog

HTNO	M1	QUIZ1	ASSIGN1	SUM1	M2	QUIZ2	ASSIGN2	SUM2	TOTAL
17B81A0401	8	6	5	19	11	9	5	25	24
17B81A0402	12	5	5	22	12	9	5	26	26
17B81A0403	4	5	4	13	9	10	5	24	22
17B81A0404	8	4	5	17	11	10	5	26	25
17B81A0405	13	6	5	24	12	10	5	27	27
17B81A0406	11	6	5	22	11	8	5	24	24
17B81A0407	7	4	5	16	11	10	5	26	24
17B81A0408	14	5	5	24	10	10	5	25	25
17B81A0409	11	5	5	21	10	10	5	25	25
17B81A0411	3	7	5	15	6	9	5	20	19
17B81A0412	10	5	5	20	10	10	5	25	24
17B81A0413	5	3	5	13	10	9	5	24	22
17B81A0414	9	5	5	19	11	9	5	25	24
17B81A0415	11	2	5	18	10	10	5	25	24
17B81A0416	8	2	5	15	9	9	5	23	22
17B81A0417	13	8	4	25	12	9	5	26	26
17B81A0418	13	6	5	24	12	10	5	27	27
17B81A0419	12	4	5	21	12	9	5	26	25
17B81A0420	5	4	5	14	9	10	4	23	22
17B81A0421	14	6	5	25	14	10	5	29	29
17B81A0423	8	4	4	16	9	10	4	23	22
17B81A0424	11	6	5	22	9	9	5	23	23
17B81A0425	11	8	5	24	12	9	5	26	26
17B81A0426	11	5	5	21	8	10	5	23	23
17B81A0427	14	5	5	24	11	9	5	25	25
17B81A0428	6	2	5	13	7	8	5	20	19
17B81A0429	9	4	5	18	8	5	4	17	18
17B81A0430	11	5	5	21	6	7	5	18	21
17B81A0431	10	2	5	17	11	10	4	25	24
17B81A0432	13	5	5	23	11	8	5	24	24
17B81A0433	12	6	4	22	9	8	4	21	22
17B81A0434	15	7	5	27	14	10	5	29	29
17B81A0435	7	3	5	15	6	10	5	21	20
17B81A0436	5	6	4	15	11	7	4	22	21
17B81A0437	7	5	5	17	7	7	5	19	19
17B81A0438	6	6	4	16	5	9	4	18	18
17B81A0439	12	3	5	20	10	10	5	25	24
17B81A0440	6	2	5	13	10	8	5	23	21
17B81A0441	12	3	5	20	8	10	5	23	23
17B81A0442	11	3	5	19	10	8	5	23	23
17B81A0443	12	1	5	18	8	9	5	22	22
17B81A0444	11	4	5	20	12	10	5	27	26

HTNO	M1	QUIZ1	ASSIGN1	SUM1	M2	QUIZ2	ASSIGN2	SUM2	TOTAL
17B81A0445	14	6	5	25	13	9	5	27	27
17B81A0447	4	3	5	12	11	8	5	24	22
17B81A0448	14	6	5	25	14	10	5	29	29
17B81A0450	11	4	5	20	9	10	5	24	24
17B81A0451	12	5	5	22	6	9	5	20	22
17B81A0453	8	4	4	16	6	5	5	16	16
17B81A0454	5	5	5	15	7	9	5	21	20
17B81A0455	15	5	5	25	14	10	5	29	29
17B81A0456	12	5	5	22	7	6	5	18	22
17B81A0457	5	3	5	13	6	3	5	14	14
17B81A0458	10	2	5	17	9	9	5	23	22
17B81A0459	12	3	5	20	14	10	5	29	28
17B81A0461	11	5	5	21	10	9	5	24	24
17B81A0462	10	5	5	20	6	9	5	20	20
17B81A0463	9	9	5	23	11	9	5	25	25
17B81A0464	14	8	5	27	10	9	5	24	27
17B81A0465	9	8	5	22	8	10	5	23	23
17B81A0466	12	4	5	21	9	10	4	23	23
17B81A0467	3	1	5	9	3	8	5	16	15
17B81A0468	5	5	4	14	8	10	4	22	21
17B81A0469	12	6	5	23	13	10	5	28	27
17B81A0470	12	7	5	24	9	9	5	23	24
17B81A0471	7	4	5	16	11	10	5	26	24
17B81A0472	13	5	5	23	13	6	5	24	24
17B81A0473	13	8	5	26	12	9	5	26	26
17B81A0474	12	7	5	24	13	10	5	28	28
17B81A0475	12	5	5	22	11	9	5	25	25
17B81A0476	7	4	5	16	8	9	5	22	21
17B81A0477	12	10	4	26	11	9	5	25	26
17B81A0478	11	8	5	24	10	10	5	25	25
17B81A0479	8	8	5	21	9	10	5	24	24
17B81A0480	13	9	5	27	12	10	5	27	27
17B81A0481	13	6	5	24	10	9	5	24	24
17B81A0482	8	4	5	17	11	9	5	25	24
17B81A0483	8	5	4	17	8	10	5	23	22
17B81A0484	9	9	5	23	9	10	5	24	24
17B81A0485	15	10	5	30	14	9	5	28	30
17B81A0487	15	9	5	29	14	10	5	29	29
17B81A0488	7	9	5	21	9	10	5	24	24
17B81A0489	9	6	5	20	9	8	5	22	22
17B81A0490	13	10	5	28	13	10	5	28	28
17B81A0491	7	8	5	20	8	10	5	23	23
17B81A0492	11	5	5	21	10	9	5	24	24
17B81A0494	11	5	4	20	7	10	4	21	21
17B81A0495	7	5	4	16	9	10	5	24	23
17B81A0496	10	3	5	18	11	9	5	25	24
17B81A0497	8	3	5	16	9	9	5	23	22
17B81A0498	14	6	5	25	14	8	5	27	27
17B81A0499	12	6	5	23	8	9	5	22	23
17B81A04A0	9	7	5	21	11	9	5	25	25

HTNO	M1	QUIZ1	ASSIGN1	SUM1	M2	QUIZ2	ASSIGN2	SUM2	TOTAL
17B81A04A1	13	9	5	27	14	9	5	28	28
17B81A04A2	14	9	5	28	14	10	5	29	29
17B81A04A3	9	4	4	17	9	8	5	22	21
17B81A04A4	15	9	5	29	14	9	5	28	29
17B81A04A5	8	6	5	19	8	9	5	22	22
17B81A04A6	11	8	5	24	11	10	5	26	26
17B81A04A7	9	5	5	19	8	7	5	20	20
17B81A04A8	8	4	4	16	4	10	4	18	18
17B81A04A9	8	5	5	18	12	10	5	27	26
17B81A04B0	12	6	5	23	13	10	5	28	27
17B81A04B1	14	8	5	27	13	9	5	27	27
17B81A04B2	11	8	5	24	13	8	5	26	26
17B81A04B3	15	5	4	24	14	10	5	29	28
17B81A04B4	13	2	5	20	12	10	5	27	26
17B81A04B5	14	6	5	25	14	10	5	29	29
17B81A04B6	5	2	5	12	13	9	5	27	24
17B81A04B7	11	5	5	21	12	6	5	23	23
17B81A04B8	12	7	4	23	11	9	5	25	25
17B81A04B9	13	9	5	27	14	10	5	29	29
17B81A04C0	11	4	5	20	14	10	5	29	28
17B81A04C1	9	6	5	20	13	9	5	27	26
17B81A04C2	12	4	5	21	15	8	5	28	27
17B81A04C3	10	3	5	18	10	9	5	24	23
17B81A04C4	14	5	5	24	15	10	5	30	29
17B81A04C5	9	5	5	19	11	10	5	26	25
17B81A04C6	11	4	5	20	8	9	5	22	22
17B81A04C7	15	4	5	24	15	10	5	30	29
17B81A04C8	15	4	5	24	15	10	5	30	29
17B81A04C9	7	6	5	18	11	9	5	25	24
17B81A04D0	14	5	5	24	14	9	5	28	28
17B81A04D1	10	3	5	18	14	10	5	29	27
17B81A04D2	14	2	5	21	15	10	5	30	29
17B81A04D3	15	6	5	26	15	10	5	30	30
17B81A04D4	11	5	5	21	14	10	5	29	28
17B81A04D5	12	5	5	22	14	10	5	29	28
17B81A04D6	12	3	5	20	12	8	5	25	24
17B81A04D7	7	4	4	15	7	8	5	20	19
17B81A04D8	11	4	5	20	14	9	5	28	27
17B81A04D9	12	7	5	24	14	10	5	29	28
17B81A04E0	9	3	5	17	10	10	5	25	24
17B81A04E1	14	4	5	23	14	10	5	29	28
17B81A04E2	15	3	5	23	15	9	5	29	28
17B81A04E3	1	5	5	11	0	9	5	14	14
17B81A04E4	3	5	4	12	8	7	5	20	19
17B81A04E5	8	3	5	16	13	9	5	27	25
17B81A04E6	8	6	5	19	13	10	5	28	27
17B81A04E7	7	4	5	16	9	10	5	24	23
17B81A04E8	9	3	5	17	14	8	5	27	25
17B81A04E9	5	5	5	15	12	10	5	27	25
17B81A04F0	3	3	5	11	11	8	5	24	22

HTNO	M1	QUIZ1	ASSIGN1	SUM1	M2	QUIZ2	ASSIGN2	SUM2	TOTAL
17B81A04F1	8	4	5	17	10	10	5	25	24
17B81A04F2	13	4	5	22	14	8	5	27	26
17B81A04F3	11	4	5	20	13	10	5	28	27
17B81A04F4	3	6	4	13	7	6	5	18	17
17B81A04F5	10	2	5	17	8	9	5	22	21
17B81A04F6	12	4	5	21	8	10	5	23	23
17B81A04F7	5	5	5	15	3	10	5	18	18
17B81A04F8	11	4	5	20	0	0	5	5	17
17B81A04F9	14	6	5	25	14	10	5	29	29
17B81A04G0	9	7	5	21	12	10	5	27	26
17B81A04G1	1	2	5	8	0	10	5	15	14
17B81A04G2	4	2	5	11	0	0	0	0	9
17B81A04G3	8	1	5	14	9	10	5	24	22
17B81A04G4	5	4	5	14	7	9	5	21	20
17B81A04G5	8	3	5	16	13	5	5	23	22
17B81A04G6	14	5	5	24	13	10	5	28	28
17B81A04G7	10	3	5	18	8	9	5	22	22
17B81A04G8	7	1	5	13	8	8	5	21	20
17B81A04G9	1	5	4	10	9	10	5	24	22
17B81A04H0	8	3	5	16	11	10	5	26	24
17B81A04H1	8	4	5	17	11	9	5	25	24
17B81A04H2	5	5	5	15	8	8	5	21	20
17B81A04H3	14	5	5	24	11	9	5	25	25
17B81A04H4	13	7	5	25	13	10	5	28	28
17B81A04H5	14	6	5	25	12	10	5	27	27
17B81A04H6	13	4	5	22	14	8	5	27	26
17B81A04H7	10	5	5	20	7	9	5	21	21
17B81A04H8	12	5	5	22	11	9	5	25	25
17B81A04H9	9	7	5	21	12	10	5	27	26
17B81A04I0	7	4	5	16	6	8	5	19	19
17B81A04I1	11	4	5	20	7	8	5	20	20
17PA1A04E3	12	5	5	22	6	10	5	21	22
18B85A0401	11	4	5	20	12	7	5	24	24
18B85A0402	5	2	4	11	0	5	5	10	11
18B85A0403	4	5	5	14	10	9	5	24	22
18B85A0404	6	3	5	14	13	8	5	26	24
18B85A0405	9	3	5	17	12	9	5	26	25
18B85A0406	3	5	5	13	10	10	5	25	23
18B85A0407	7	5	5	17	9	10	5	24	23
18B85A0408	10	5	5	20	9	10	5	24	24
18B85A0409	5	4	5	14	5	10	5	20	19
18B85A0410	5	5	5	15	12	10	5	27	25
18B85A0411	4	3	5	12	10	9	5	24	22
18B85A0412	2	3	5	10	7	10	5	22	20
18B85A0414	10	4	5	19	14	8	5	27	26
18B85A0415	4	4	5	13	5	9	5	19	18
18B85A0416	9	5	5	19	13	10	5	28	27
18B85A0417	10	4	5	19	11	9	5	25	24
18B85A0418	8	3	5	16	14	8	5	27	25
18B85A0419	10	4	5	19	14	10	5	29	27

HTNO	M1	QUIZ1	ASSIGN1	SUM1	M2	QUIZ2	ASSIGN2	SUM2	TOTAL
18B85A0420	6	4	5	15	1	10	5	16	16
18B85A0421	4	5	5	14	11	10	5	26	24
18B85A0422	8	3	5	16	10	10	5	25	24
18B85A0423	6	4	5	15	10	8	5	23	22
18B85A0424	7	3	5	15	12	9	5	26	24
18B85A0425	8	5	5	18	11	9	5	25	24
18B85A0426	13	5	5	23	13	8	5	26	26
18B85A0427	5	6	5	16	10	10	5	25	24
18B85A0428	5	3	5	13	7	10	5	22	21
18B85A0429	3	3	5	11	8	8	5	21	19
18B85A0430	9	3	5	17	9	9	5	23	22
18B85A0431	4	3	4	11	4	9	5	18	17
18B85A0432	7	2	5	14	10	9	5	24	22
18B85A0433	2	2	4	8	8	9	5	22	20
18B85A0434	0	0	0	0	0	0	0	0	0
18B85A0435	11	4	5	20	13	9	5	27	26
18B85A0436	5	6	5	16	7	10	5	22	21
18B85A0437	4	4	5	13	7	9	5	21	20

Date:30-04-2021

Controller of Examinations