

CIRCULAR :

A reference is invited to the Ordinances, Regulations and syllabi relating to the Bachelor of Engineering degree course vide this Office Circular No. UG/347 of 2002, dated 17th August, 2002 and the Principals of the affiliated Colleges in Engineering are hereby informed that the recommendation made by the Faculty of Technology at its meeting held on 26th March, 2008 has been accepted by the Academic Council at its meeting held on 15th April, 2008 vide item No.4.31 and that, in accordance therewith, the scheme of examination and syllabi for the Second year (Sem. III & IV) leading to the B.E. degree course for the Computer Engineering is revised as per Appendix and that the same will be brought into force with effect from the academic year 2008 - 2009.

MUMBAI-400 032

June, 2008

for REGISTRAR

The Principals of the affiliated colleges in Engineering.

CA.31/15.4.2008

UG/ 211-A of 2008,

MUMBAI-400 032

5th June, 2008

Copy forwarded with compliments for information to :-

- 1) The Dean, Faculty of Technology,
- 2) The Chairman, Board of Studies in Mechanical Engineering .
- 3) The Controller of Examinations,
- 4) The Co-Ordinator, University Computerization Centre,

for REGISTRAR

Copy to :-

Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), Director of Students Welfare, the Executive Secretary to the Vice-Chancellor, the Pro-Vice Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information .
The Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies), Record Section (copies), Publications Section (5 copies), the Deputy Registrar, Enrolment, Eligibility and Migration Section (copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanagari (copies), the Deputy Registrar, Affiliation Section (2 copies), the Director, Institute of Distance Education, (copies) the Director University Computer Center (IDE Building), Vidyanagari, (2 copies) the Deputy Registrar (Special Cell), the Deputy Registrar (PRO) the Assistant Registrar. Academic Authorities Unit (2 copies) and the Assistant Registrar.

UNIVERSITY OF MUMBAI



Revised Syllabus
and Scheme of Examination
For
The Second Year
(Sem. III & IV)
of the

B.E. Degree Course
in Production Engineering

(With effect from the academic year 2008-2009)

SCHEME OF INSTRUCTIONS AND EXAMINATION (R-2008)

UNIVERSITY OF MUMBAI

COURSE: B.E. (PRODUCTION ENGINEERING)

YEAR: S.E., SEMESTER: III

Subjects	No. of periods of 1Hour			Duration of Theory Paper in Hours	Marks				
	Lecture	Practical	Tutorial		Theory Paper	Term Work	Practical	Oral	Total
Applied Mathematics	4	-	2	3	100	25	-	-	125
Strength of Materials	4	2	-	3	100	25	-	25	150
Manufacturing Engineering I	3	-	-	3	100	-	-	25	125
Engineering Graphics and Machine Drawing	2	3	-	4	100	50	-	-	150
Theory of Machines	5	2	-	4	100	25	-	25	150
Presentation and Communication Techniques S	2	2	-	-	-	25	-	25	50
Workshop Practice - III	-	3	-	-	-	50	50	-	100
TOTAL	20	12	2	-	500	200	50	100	850

Common with all branches

COURSE: B.E. (PRODUCTION ENGINEERING)

YEAR: S.E., SEMESTER: IV

Subjects	No. of periods of 1Hour			Duration of Theory Paper in Hours	Marks				
	Lecture	Practical	Tutorial		Theory Paper	Term Work	Practical	Oral	Total
Applied Probability and Statistics	4	-	-	3	100	-	-	-	100
Fluid Mechanics and Fluid Power	3	2	-	3	100	25	25	-	150
Manufacturing Engineering II	3	-	-	3	100	-	-	-	100
Electrical and Electronics Engineering	4	2	-	3	100	25	-	-	125
Thermal Engineering	5	2	-	3	100	25	25	-	150
Engineering Design	4	2	-	4	100	25	-	-	125
Workshop Practice -IV	-	3	-	-	-	50	50	-	100
TOTAL	23	11	-	-	600	150	100	-	850



University of Mumbai

ASS: S.E. (PRODUCTION ENGINEERING)

Semester-III

SUBJECT: APPLIED MATHEMATICS (P)

Periods per week 01 Period of 60 min	Lecture	4	
	Practical	-	
	Tutorial	2	
Evaluation System		Hours	Marks
	Theory Examination	3	100
	Practical Examination	-	-
	Oral Examination	-	-
	Term Work	-	25
	Total		100

Objective

Study as an allied discipline to prepare a theoretical base for general understanding and application in production engineering.

Approach

Emphasis on concepts, principles and analytical treatment supplemented by problem solving.

Weightage

Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

Sr. No.	Details	Hrs
01	Laplace Transforms : Definition & formulae (without proof) for the L. T. of standard functions; Properties (without proof). Problems using the above formulae and properties.	06
02	Inverse Laplace Transform : Formulae and properties and simple problems using direct applications of the above, NO PROOF More Problems using Inverse L.T., Partial Fractions Method, Convolution Theorem (without proof) applications to find inverse LT.(NO THEORY TO BE ASKED IN EXAM) Solutions of ordinary differential equations (using boundary and initial conditions) (No unit step function, No periodic function).	08

Matrices: Types of Matrices: Orthogonal, Symmetric, Skew symmetric, Unitary, Hermitian, Skew Hermitian. Definitions, Results and Theorems, (problems based on the above).

Adjoint of Matrix

Formula for inverse in terms of adjoint inversion Method to solve a system of non homogeneous equations. (Explanation of the methods and problems). Properties of adjoint (only statement) and problems based on the properties (No theory to be asked) Elementary Operations & applications. Reducing a matrix to Normal form, Echelon form and hence find the rank of the given matrix. Solutions of Homogeneous and Non-Homogeneous equations (stating the conditions in terms of rank & problems) (No partition of matrices)

08

Eigen values and Eigen Vectors: I

Definitions, properties (only statement). Problems to find Eigen values, Eigen vectors. Cayley Hamilton Theorem (statement & application). To find the inverse of a matrix and to reduce a given polynomial and find its value.

08

Definitions and results: Complex-valued function, Analytic function, singular points, Regular function. Necessary and Sufficient condition for analytic functions (only statement). Cauchy, Riemann equations in Cartesian and Polar form (ONLY STATEMENT & PROBLEM)

Problems: To find the analytic function, given (i) u (ii) v (iii) $u+v$ (iv) $u-v$ using Milne Thompson Method) & other problems.

Definitions & Problems of the following: Harmonic function, Orthogonal Trajectories (ONLY PROBLEMS & THEOREMS WITHOUT PROOF)

Bilinear Transformation: Definition of bilinear transformation, critical points, fixed points, cross ratio & problems. (ONLY STATEMENT OF THEOREMS ON CROSS RATIO & FIXED POINTS)

12

GIVEN the following transformations to find the of given curve or its pre-image.

$(W = 1/Z, Z^2), (az+b)/(cz+d), (ad-bc \neq 0), \frac{1}{2}(z-1/z)$

Complex Integration: Only Line Integrals (direct evaluation) independent only statement of path condition) NO CAUCHY'S OR RESIDUES THEOREMS & INTEG. formulae)

Introduction of Fourier series: Fourier series of periodic functions with period 2π & $2l$ even and odd functions, half range Sine and Cosine series, & Parseval's identity (only statement & problems) no derivations. (Complex form of Fourier series and Fourier transform not to be included).

04

References:

- 1) Elements of Applied Mathematics, Vol III & IV
- 2) Engineering Mathematics Vol, III
- 3) Matrices
- 4) Complex Variable
- 5) Matrices
- 6) Theory of Function of Complex Variable
- 7) Complex Variables
- 8) Laplace Transforms
- 9) Engineering Mathematics

by P.N.Wartikar

by Khumbojkar.

by Vasistha

by M L Khanna

by Shanti Narayan

by Shanti Narayan

by Schaum's Series

by Schaum's Outline Series

by Bali.Saxena.Iyenger

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COURSE: (PRODUCTION ENGINEERING)

Semester-III

SUBJECT: STRENGTH OF MATERIALS (P)

Periods per week
01 Period of 60 min

Lecture 4

Practical 2

Tutorial -

Evaluation System

Theory Examination

Hours

Marks

3

100

Practical Examination

-

-

Oral Examination

-

25

Term Work

-

25

Total

150

Objective

The aim of the syllabus is to make the student conversant with various types of forces /loading and the resulting stresses there on to which mechanical components and structures are subjected to. This subject will serve as a strong basis for the students in understanding and appreciating the stress-strain behavior and give better insight in developing their design skills in the subjects like Engineering Design, Machine Tool Design, Design of Press Tools, Design of Jigs & Fixtures and Project Work.

Approach

Emphasis on concepts, principles and analytical treatment supplemented by problem solving.

Weightage

Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

Sr.No.	Details	Hrs
01	Simple Stress and Strains : Direct stress and direct strain: stress-strain curves: deformation of uniform/tapering rectangular and circular cross-section bars; deformation of members made of composite materials; factor of safety; shear stress and shear strain: poisson's ratio: volumetric strain: bulk modulus; relationship between Young's modulus, bulk modulus and modulus of elasticity; temperature stresses in simple and compound bars.	06
02	Shear force and bending moment: Axial force, shear force and bending moment diagrams for statically determinate beams excluding beams with internal hinges for different types of loading.	05

03	Simple theory of bending: Flexure formula for straight beams; principal axes of inertia; moments of inertia about principal axes; transfer theorem. Simple problems involving application of flexure formula, section modulus and moment of resistance of a section.	04
04	Shear stress in beams: Distribution of shear stress across plane sections used commonly for structural purposes; shear connectors.	04
05	Simple theory of torsion: Torsion of circular shafts-solid and hollow, stresses in shafts transmitting power, shafts in series and parallel; keys and couplings.	04
06	Bending moment combined with axial loads : Application to members subjected to eccentric loads, core of section.	04
07	Principal stresses : General equations for transformation of stress; principal planes and principal stresses, determination using mohr's circle maximum shear stress, principal stresses in beams; principal stresses in shafts subjected to torsion, bending and axial thrust; concept of equivalent torsional and bending moments	06
08	Deflection of beams: Deflection of cantilevers, simple supported and overhanging beams using double integration and Macaulay's method for different types of loadings.	04
09	Struts : Struts subjected to axial loads, concept of buckling , Euler's formula for struts with different support conditions, Euler's and Rankine's design formulae	
10	Strain energy: Strain energy due to axial loads, gradually applied transverse loads and under impact load.	03

Practicals;

List of experiments

- 1) Tension test on mild steel bar (Stress Strain behaviour , modulus of elasticity determination)
- 2) Tension test on Tor steel bar.
- 3) Shear test on mild steel, aluminium, brass.
- 4) Flexure test on wood. (Determination of bending strength of wooden beam)
- 5) Deflection test (single central point load and two point load)
- 6) Izod impact test.
- 7) Charpy impact test.
- 8) Torsion Test on mild steel bar / cast iron bar

Term work:
Report on laboratory experiments based on the above chapters and at least 6 experiments must be conducted from the list given as above in list of experiments.
At least five assignments comprising of minimum 5 problems in each assignment from among the ten chapters of the detailed syllabus must be submitted along with the laboratory reports and test papers.
At least one class test must be conducted at the middle of the semester and 10 marks weightage must be assigned for the evaluation of test in the term work.

References:

Mechanics of materials by E.P.Popov Prentice Hall of India Pvt. Ltd.
Mechanics of structures of S.B.Junnarkar, Charotar publishers
Strength of materials by T.S. Venkatesh
Strength of materials by M.D.Dayal
Strength of material by R.K.Rajput, S Chand publications

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COURSE: (PRODUCTION ENGINEERING)

Semester-III

SUBJECT: MANUFACTURING ENGINEERING I (P)

Periods per week
of Period of 60 min

Lecture 3

Practical -

Tutorial -

Evaluation System

Theory Examination

Hours

Marks

3

100

Practical Examination

-

-

Oral Examination

-

25

Term Work

-

-

Total

125

Objective

Understanding of types, construction, functional features and use of metal cutting machine tools, and operations on work piece and production related requirements.

Approach

Emphasis on role and capability of machine tools as productive source & cost center, leading to engineering decisions, affecting quality and productivity.

Weightage

Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

Sr.No.	Details	Hrs
01	Definition, need and classification of machine tools :Brief history and development, typical features, associated with cutting, tools and Performance measures of machine tools.	02
02	Turning machine lines and processes: Lathe as general purpose turning machine, principle of generating surfaces, lathe specifications, description and functions of lathe, principle parts, back gear-all gear drive, feed mechanism, lathe accessories, and attachments - chucks, collets, mandrel, face plate, Lathe operations, taper turning methods thread cutting, cutting tools & tool geometry, Capstan and turret lathes : Principal parts of capstan and turret lathes, difference between capstan and turret lathe, work holding devices, tool holding devices, tool dies, chasers, taps, etc., tool layout for simple components like bolt, nut.	08

	pin. shaft. Single point cutting tools: Types, geometry, materials.	
	Drilling machines and processes : Types-sensitive, upright, radial, gang, multiple spindle, automatic drilling machines, work and tool holding devices, drilling machine operation, types and materials of drills, twist drill nomenclature. Counter-boring-types of counter bores. Spot facing-Types of spot facers. Countersinking-types of countersinks. Reaming-Types of reamers. Tapping-Hand tap and machine tap. Machining time in drilling. Deep hole drilling (only fundamentals to be covered) : Gun drills, deep hole drilling machines. Boring Machine.	04
	Reciprocating machine tools : Shaping machines: types of shapers, working of shaping machine, quick return mechanisms, shaper operations, machining time, Planing machines: types of planing machines, planer mechanisms, feed mechanisms, work holding devices, shaper vs. planer, Slotting machines: types of slotting machines, quick return mechanisms.	04
	Milling machines : Types of milling machines-column and knee type, fixed bed type, planer type and special type, milling processes, conventional and climb milling, milling cutters, peripheral, face and shell milling cutters, geometry and materials of milling cutters, attachments and special accessories for milling, universal dividing head, indexing methods, direct, plain, compound and differential indexing mechanisms, arbors, adaptors and collets, chucks, calculations of machining time, copy milling machines.	08
	Broaching machines: Broaching process, elements of typical internal broach, types of broaches, broaching machines-vertical, horizontal, surface and continuous broaching vs. other processes (design of broaches omitted).	04
	Cutting off machines: Power hack-saws, band saw and circular saw, friction saw and abrasive cutting off machines, field of applications and limitations, tools and accessories.	04
	Finishing Processes: Honing-process, machine, honing stone, and tools, abrasive, grit size... Lapping-process, hand and machine lapping, flat internal and external cylindrical lapping, lap materials, medium, vehicles. Super finishing process-equipments, stones, fluids. Roller burnishing-process, tools, applications.	04

References:

Production Technology	by	HMT T.M.H. Publishing Co.
Elements of workshop Technology	by	Hajra Chowdhary and Bose . Vol II
Material and manufacturing processes	by	De Garmo
Manufacturing process	by	Begman.
Production Technology	by	Raghuvanshi

Production Technology
Production Technology

by Chapman Vol 1 and 2 and 3
by R.K. Jain

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COURSE (PRODUCTION ENGINEERING)		Semester-III	
COURSE ENGINEERING GRAPHICS AND MACHINE DRAWING (P)			
Periods per week at Period of 60 min	Lecture	2	
	Practical	3	
	Tutorial	-	
Evaluation System		Hours	Marks
	Theory Examination	4	100
	Practical Examination	-	-
	Oral Examination	-	-
	Term Work	-	50
	Total		150

Objective
To develop proficiency in use of drawing as a communication medium and information document between designer and producer.

Approach
Emphasis on procedural skills in representing 3-D objects as 2-D views in proportions and neatness of layout and information.

Weightage
Proportional to the number of 'Hrs' indicated in the right column below.

Units of Syllabus

No.	Details	Hrs.
01	Interpenetration of solids : Cylinder to cylinder, cone to cylinder, prism to prism, prism to cylinder, pyramid to prism, pyramid to cylinder of only regular solids with axis of solids perpendicular to/or parallel to the reference planes (neglecting the axis of solids inclined to any reference plane)	06
02	Auxiliary projections of solids using front view, top view and side views.	02
03	Machine Elements: Screw fasteners: Thread nomenclature, forms of screw threads. V threads, Square thread, ACME, Buttress, and Whitworth. Representation of threads, Hexagonal headed bolts and nuts, square headed bolts & nuts, locking devices for nuts. Keys, cotters and pin joints: Keys-saddle keys, sunk keys, round keys Cotter joints: socket and Spigot joint, Gib and Cotter joint, Cotter and	06



Sleeve Joint. Pin joint-Knuckle joint. .

Couplings : Rigid couplings. Split. Muff. Flanged protected type.
Flexible bush pin type.

Assembly & Detail Drawings:

Machine tools parts: Machine swivel vice, pipe vice, screw jack, tailstock, tool head of shaper, Simple drill jig & milling fixture.
Bearings: Plummer block, foot bearing, bracket with pedestal bearing, footstep bearing with radial and thrust ball bearings.
IC Engine parts : I.C. Engine connecting rods, stuffing box, and eccentric
Valves: Feed checks valve, Non Return valve, stop valve, Relief valve, lever safety valve.

06

Gears: Profile of involute gear teeth, methods of drawing gear tooth profiles, I.S. 'conventional representation of spur gears, bevel gears.
Pulleys with flat belt, v-belt, and rope.

02

Limits, fits and tolerances. Selection of tolerances, methods of placing limit dimensions, fits.

02

Term work:

Each candidate shall submit 8 sheets of A2 size (half imperial) as given below.

1. One sheet comprising of at least 4 problems from chapter no 1.
2. One sheet comprising of at least 4 problems from chapter no 2.
3. One sheet of free hand sketches comprising of at least 6 problems from chapter no 3.
4. Two sheets of assembly and two sheets of part or detailed drawing from chapter no 4 comprising of at least 2 problems in assembly and 2 problems in part drawing.
5. One sheet comprising of at least 4 problems from chapter no 5 and 6.
6. One class test must be conducted at the middle of the semester and 10 marks weightage must be assigned to it and must be submitted along with the above sheets.
7. One sheet of assembly and one sheet of details on any Computer aided software (Sheet size is flexible).

References:

Machine Drawing by N D Bhat

Machine Drawing by Sidheshwar

Machine Drawing by P S Gill

Machine Drawing by Narayana and Reddy

General Principles of Presentation on Technical Drawing-IS:10714-1983

✓ Guide for the selection of Fits- IS:2709-1964

University of Mumbai

CLASS: SE (PRODUCTION ENGINEERING)
SUBJECT: THEORY OF MACHINES (P)

Semester-III

Periods per week
01 Period of 60 min

Lecture 5
Practical 2
Tutorial -

Evaluation System

	Hours	Marks
Theory Examination	4	100
Practical Examination	-	-
Oral Examination	-	25
Term Work	-	25
Total		150

Objective

To introduce as a tool for static and dynamic analysis of mechanisms for use in designs and engineering.

Approach

Equal emphasis on concepts, principles and analytical treatment supplemented by problem solving.

Weightage

Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

Sr. No.	Details	Hrs
01	Basic concepts: Links, kinematics pairs, kinematics pairs giving one, two and three degrees of freedom, kinematics chains, degree of freedom and movability criterion, Constrained kinematics chains as mechanism, Inversions of single and double slider crank chains and their applications. Introduction to simple mechanisms- pantograph, straight line motion mechanism, Engine indicators, viz., Simplex) Cross by, Thomson and Dobbie McKines indicators, automobile steering gears.	04
02	Motion characteristics of mechanisms: Velocity and acceleration analysis of mechanisms with single degree of freedom system using graphical method. Instantaneous centre, Kennedy's theorem; analysis of velocities of mechanism using instantaneous centre method, Analytical technique applied to only slider crank mechanism, Bennett's construction and Rotterdam's construction.	08

06	CAMS: Introduction, types of cams, types of followers. Follower motions, viz. simple harmonic motions, constant velocity, uniform and constant acceleration & retardation and cycloidal motion, layout of cam profile for specified displacement characteristics. Cams with oscillating follower system.	06
07	Clutches Brakes and Dynamometers: Study and analysis of single plate clutch, multiple plate clutches and cone clutches. Introduction, types of brakes, viz. block and shoe brakes, band brake, band and block brakes, braking of vehicles. Types of dynamometers, viz. Prony brake, Rope brake, belt transmission dynamometers.	08
08	GEARS Introduction: Types of gears and applications, Gear terminology. Condition for constant velocity ratio-conjugate profiles-profiles used in gears. Interference of involute teeth, methods of preventing interferences, under cutting, length of path of contact and contact ratio. Gear trains-Simple, compound, planetary and epicyclic gear trains	08
09	Turning moment diagram and flywheel Piston effort, crank effort, turning moment, coefficient of fluctuation of speed and energy, calculation of flywheel dimensions.	04
10	Balancing Introduction, rotary masses -several masses in same plane, several masses in different planes, balancing of reciprocating masses, primary balance and secondary balance, Balancing of locomotives-Hammer Blow and variation of tractive efforts, static dynamic balancing machines	04
11	Vibrations Introduction-free vibrations; longitudinal, transverse and torsional vibrations, Dunkerl's empirical equations, critical or whirling speed of shaft, Torsional vibrations of two rotor system -torsionally equivalent shaft -free torsional vibrations of a geared system. (Damped and forced vibrations are excluded)	04
12	Gyroscope Introduction-Gyroscopic couple and precision stabilization of ships and Air crafts only.	02

Term work

- 1) At least five sheets consisting of four problems in each chapter from chapter no 1 to 5, on half imperial drawing sheets in kinematics section.
- 2) At least four assignments consisting of four problems in each assignment from chapter no 6 to 10 from dynamic section.
- 3) At least six experiments to be conducted from dynamic section and report must be submitted along with all the assignment as stated above and the test paper.

4) At least one class test must be conducted at the middle of the semester and 10 marks weightage must be assigned for the evaluation of test in the term work and must be submitted along with the above as shown in 1, 2 and 3.

References:

- | | |
|---------------------------|---------------------------|
| 1) Theory of Machines | by Thomas Bevan |
| 2) Theory of Machines | by Green |
| 3) Theory of Machines | by Ballaney |
| 4) Theory of Machines | by S.S.Ratan |
| 5) Theory of Machines | by Jagdishlal |
| 6) Mechanisms of Machines | by J Hannah & R C Stephen |

CLASS: S.E (Production Engineering)		Semester - III	
SUBJECT: Presentation and Communication Techniques			
Periods per week (each of 60 min.)	Lecture	2	
	Practical	2	
	Tutorial	-	
Evaluation System	Theory Examination	Hours	Marks
	Practical examination	--	--
	Oral Examination	--	--
	Term Work	--	--
	Total	--	50
			50

Detailed Syllabus

1. Communication in a business organization:

Hrs.

Internal and external communication, Types of meetings, strategies for conducting successful business meetings, documentation (notice, agenda, minutes, resolution) of meetings. Introduction to modern communication techniques.

06

(e-mail, internet, video-conferencing, etc.) Legal and ethical issues in communication (Intellectual property rights: patents, TRIPS, Geographical indications).

Advanced technical writing:

2

Report writing: Definition and importance of reports, qualities of reports, language and style in reports, types of reports, formats (letter, memo, project-reports). Methods of compiling data for preparing report.

08

A computer-aided presentation of a technical project report based on survey-based or reference based topic. The topics are to be assigned to a group of 8-10 students. The written report should not exceed 20 printed pages.

Technical paper-writing, Writing business proposals.

3

Interpersonal skills:

04

introduction to emotional intelligence, motivation, Negotiation and conflict resolution, Assertiveness, team-building, decision-making, time-management, persuasion

4

Presentation skills:

04

Elements of an effective presentation, Structure of a presentation, Presentation tools, Audience analysis, Language: Articulation, Good pronunciation, Voice quality, Modulation, Accent and Intonation.

Career skills:

04

- 5 Preparing resumes and cover letters. Types of Resumes, Interview techniques: Preparing for job interviews, facing an interview, verbal and non-verbal communication during interviews, observation sessions and role-play techniques to be used to demonstrate interview strategies (mock interviews).

Group discussion:

04

- 6 group discussions as part of selection process. Structure of a group discussion, Dynamics of group behavior, techniques for effective participation, Team work and use of body language.

Term work: Part-I (25 Marks): Assignments;

2 assignments on communication topics

3 assignments on report-writing

3 assignments on interpersonal skills

2 assignments on career skills

At least one class test (written)

Distribution of term work marks will be as follows:

Assignments : 10 marks

Written test : 10 marks

Attendance (Theory and Practical) : 05 marks

Term work: Part-II (25 Marks): Presentation;

Distribution of term work marks will be as follows:

Project report presentation : 15 marks

Group discussion : 10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Books recommended:

1. Fred Luthans: Organizational behavior, McGraw Hill
2. Lesikar and Petit, Report writing for business, Tata McGraw Hill
3. Huckin & Olsen, Technical writing and professional communication, McGraw Hill
4. Wallace & Masters, Personal development for Life & work, Thomson Learning.
5. Heta Murphy, Effective Business Communication, McGraw Hill
6. Ramani and Sharma, Report writing.

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CLASS: S.E. (PRODUCTION ENGINEERING)

Semester-III

SUBJECT: WORKSHOP PRACTICE III (P)

Periods per week
01 Period of 60 min

Lecture

Practical

Tutorial

Hours

Marks

Theory Examination

Practical Examination

Oral Examination

Term Work

Total

Evaluation System

Objective

To develop procedural and manual skills in machining and to learn the operations of different machine tools.

Approach

Training in use and control of machine tools, selection and use of cutting tools, measuring instruments, maintenance and safety aspects.

Weightage

Performance and skill of the work carried out from among the operations shown in detailed syllabus will be evaluated.

Details of Syllabus

Sr. No.	Details	Hrs
01	1. Machine shop: 1.1 One job on plain and taper turning. 1.2 One job on turning, taper turning and screw cutting. 1.3 One job on shaping machine with horizontal and inclined surfaces. 1.4 One job on milling machine. 1.5 One job on cylindrical grinding or surface grinding machine.	22
02	Moulding shop: Sufficient practice (about 3 to 4 moulds) of preparing different sand moulds.	14

Term work:

Should contain the jobs done as shown above in 1.1 to 1.5 of the detailed syllabus.

Practical Examination shall be of 3 Hours duration. The job should consist of at least three operations as mentioned in 1.1 to 1.5

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CLASS: S.E. (PRODUCTION ENGINEERING)

Semester-IV

SUBJECT: APPLIED PROBABILITY AND STATISTICS (P)

Periods per week
01 Period of 60 min

Lecture 4
Practical -
Tutorial -

Evaluation System

	Hours	Marks
Theory Examination	3	100
Practical Examination	-	-
Oral Examination	-	-
Term Work	-	-
Total		100

Objective

To prepare the student so as to enable him/her to apply standard Statistical techniques to problems in production Engineering involving areas of uncertainty such as inventory, maintenance, quality, resource availability and demand etc.

Approach

Standard statistical techniques should be presented to the students from computational point of view. Mathematical proofs for technical results should, as far as possible, be avoided. However basic concepts and limitations of all statistical techniques must be specified. Applications of standard statistical technique should be illustrated by means of a large number of numerical problems from production engineering and industrial statistics.

Weightage

Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

Sr. No.	Details	Hrs
01	<u>Probability Theory</u> a) Concept of random experiment, Sample points, sample space, types of events : Mutually exclusive, indep, equally likely Probability (event) function (with axioms stated) 1. Addition & Multiplication Theorem on Probability (without Proof) Bayes' Theorem (only statement & problems)	06
02	<u>Random Variables</u> a) Definitions : Random Variable (Discrete & Continuous) Probability mass & density functions, Cumulative Dist Functions b) Expectation, variance, co-variance, Moments (about origin and	10

	about mean) moment generating function with derivation of moments using M.G.F. Co efficient (M.G.F.) of correlation & Kurtosis in terms of central moments (only formulae & Problems)	
	Theoretical Distributions 1) Binomial 2) Poisson 3) Normal and standard normal (with definitions and problems of mean , variance & moments)	
	Correlation & Regression : a) Karl Pearson's Correlation coefficient (definition , properties - no proof (only Problems) b) Rank no proof correlation (Spearman) with ranks repeated non-repeated c) Regression Analysis: Regression lines of X on Y and Y on X using principle of least squares (normal using equations) and also by direct regression coefficients. d) Fitting of curves: Only straight line and parabola.	08
	Tests of Hypothesis : a) Definitions : Population , sample Null and alternate hypothesis. Type - I & Type - II errors. level of significance. critical region. degree of freedom small and large sample. b) Procedure for Test of Hypothesis (use of statistical tables) Students' t-test (Small Samples) To test the significant difference between a) Sample (single) mean & population mean. (only problems) b) Two sample means (independent. & Dependent Paired t-test.(only problems) Chi-square test (only problems) a) Independence of attributes (using contingency table) Fitting of Binomial & Poisson distributions with test for goodness of fit.	10
05	Large Sample Test (Z - transform or Normal test) a) Single sample mean & population mean b) Two sample mean	08
06	Analysis of Variance (F-test) (only problems) a) One way Classification (Short-cut method & coding method) b) Two - way classification (Short-cut method & coding method) c) Latin square (Short-cut method & coding method)	06

Reference:

-) Probability and Statistics for Engineers and Scientists by Walpole. Pearson education
-) Statistical Methods : S.P.Gupta
-) Probability & Statics : Schaum series
-) Introductory statistics by Weiss, Pearson education
-) Probability and Statistical Inference by Hogg/Rao, Pearson education
-) Mathematical Statistics : Gupta & Kapoor
-) INTERNET REFERENCE: www.ocw.mit.edu

University of Mumbai

CLASS: SE (PRODUCTION ENGINEERING)

Semester-IV

SUBJECT: FLUID MECHANICS AND FLUID POWER (P)

Periods per week
01 Period of 60 min

Lecture 3

Practical 2

Tutorial -

Evaluation System

Theory Examination

Hours

Marks

3

100

Practical Examination

-

25

Oral Examination

-

-

Term Work

-

25

Total

150

Objective

Prepare a theoretical base for use of fluid power for general understanding and in production technology, machine tools, automation and instrumentation.

Approach

Emphasis on concepts, principles and applications supplemented by problems.

Weightage

Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

Sr. No.	Details	Hrs
01	General properties of fluids and fluid static: Viscous fluids "Newtonian and non-Newtonian, their stress strain relationship (general description only) pressure at a point in fluid, Variation of pressure with depth, fluid application to manometer, transmission of pressure in a fluid, thrust on plane surface, centre of pressure horizontal, and vertical plane surfaces and inclined plane surfaces, forces on immersed bodies.	06
02	Fluid Dynamics: Various types of flow (general description only), continuity equation, energy equation, momentum equation. Application. of energy and continuity equation for fluid flow measurement closed conduit (No derivations, only applications are to be imparted).	04

03	Flow in pipes: Laminar and turbulent flow in pipes (elementary treatment only), Darcy's equation, and laminar flow between flat parallel stationary plates. Laminar flow between parallel plates one of which is moving, losses in bends, couplings and valves.	04
04	Hydraulic pumps and motors: Introduction, variable capacity and fixed capacity types gear, vane and piston pumps, ram units and rotary actuators performance curves for variable speed drives, combination of pump and motor units.	07
05	Valves: Introduction, types of valves viz. "check valve, relief valve, speed control valves, pressure compensating valves, pressure compensated flow control valves, unloading valves, direction control valves, sequence valves and counter balance valves.	07
06	Oil Hydraulic circuits: Introduction, basic circuits, general classification of valves in circuit, meter-in circuit, meter-out circuit.	07

Term work:

- 1) Report on laboratory experiments based on the above chapters. At least 6 experiments are to be conducted.
- 2) At least five assignments comprising of minimum 5 problems in each assignment must be submitted along with the laboratory reports from among the above 6 chapters.
- 3) At least one class test must be conducted at the middle of the semester and 10 marks
- 4) weightage must be assigned for the evaluation of test in the term work.
- 5) The final report should contain all of the above as shown in 1, 2 and 3.

References:

- 1) Fluid Mechanics by V.L. Streeter and E.B. Wylie
- 2) Fluid Mechanics and Hydraulic Machines by R.K. Bansal.
- 3) Power Hydraulics by A.B. Goodwin.
- 4) Industrial Hydraulics Manual by Sperry & Vickers Co.
- 5) Hydraulic and Pneumatic Power by H.L. Stewart.
- 6) for Production
- 7) Fluid mechanics and hydraulic machines by R.K. Rajput

University of Mumbai

CLASS: S.E. (PRODUCTION ENGINEERING)

Semester-IV

SUBJECT: MANUFACTURING ENGINEERING II (P)

Periods per week
01 Period of 60 min

Lecture 3

Practical -

Tutorial -

Hours

Marks

Theory Examination

3

10%

Practical Examination

-

-

Oral Examination

-

-

Term Work

-

-

Total

10%

Evaluation System

Objective

Understanding of types, construction, functional features and use of metal cutting machine tools and operation on work piece and production related requirements

Approach

Emphasis on role and capability of machine tools as a productive resource and cost center, leading to engineering decisions affecting quality and productivity.

Weightage

Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

Sr. No.	Details	Hrs
01	Automats: Major classification, horizontal and vertical, single spindle and multi-spindle, bar type and chuck type, screw type and Swiss type, tools and tool holders, typical tooling setup for simple work pieces, special attachments, threading attachments, high speed drilling attachments, chutes, magazines, and hoppers for feeding.	06
02	Numerically Controlled Machines. NC and CNC lathes, CNC turning centers, paper tape, magnetic tapes, working principles Machining centers, special purpose machines.	06

03	Grinding Machines: Grinding process, grinding machines-cylindrical, centre type, universal, plain, plunge centre type, chucking type, centreless grinding machines-through feed, in feed, end feed, internal grinding machines- horizontal, vertical spindle-rotary/reciprocating types, tool and cutter grinders, special grinding machines.	02
04	Grinding wheels : Types of abrasives-natural, artificial, grain size, types of bonds, grade, structure, shapes and sizes, 18 for marking system of grinding wheel, selection of grinding wheels, grinding fluids, balancing of grinding wheels, truing and dressing, mounting of grinding wheels, safety.	02
05	Screw Thread Cutting Machines: Thread production process, thread chasing, thread milling, thread whirling, die threading and tapping, thread rolling, thread grinding, self opening die heads, chasers - radial, and tangential (tool geometry omitted).	06
06	Gear Teeth Cutting Machines: Gear milling, gear hobbing- principles of hobbing (kinematics omitted), hobbing techniques, hob size, material (tool geometry omitted), gear shaper cutter (tool geometry omitted), Gear finishing processes-gear shaving, gear lapping, gear grinding, gear burnishing.	06
07	Modern Development Machining Centers , Special Purpose Machine	02
08	Unconventional machining processes (only basic principles, machines and application). Electrical discharge machining (EDM). Electrochemical machining (ECM) Chemical machining (CHM) Ultrasonic machining (USM) Abrasive jet machining (AJM) Laser beam machining (LBM) Electron beam machining (EBM) Plasma arc machining (PAM)	06

References:

1) Production Technology	by	HMT T.M.H. Publishing Co.
2) Elements of workshop Technology	by	Hajra Chowdhary and Bose , Vol II
3) Material and manufacturing processes	by	De Garmo
4) Manufacturing process	by	Begman.
5) Production Technology	by	Raghuvanshi
6) Production Technology	by	Chapman Vol 1 and 2 and 3
7) Production Technology	by	R.K. Jain

University of Mumbai

CLASS: S.E. (PRODUCTION ENGINEERING)

Semester-IV

SUBJECT: ELECTRICAL AND ELECTRONICS ENGINEERING (P)

Periods per week
01 Period of 60 min

Lecture 4

Practical 2

Tutorial -

Hours

Marks

Theory Examination

3

100

Practical Examination

-

-

Oral Examination

-

-

Term Work

-

25

Total

125

Evaluation System

Objective

Study as an allied discipline, of electrical energy and devices used in production engineering, machine tools, instrumentation and automation.

Approach

Emphasis on concepts, principles and applications.

Weightage

Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

Sr. No.	Details	Hrs
01	Electromechanical Energy Conversion: Three phase induction motor, working principle, construction, types, and torque speed characteristics of DC Machines. DC Generator - working principle, EMF equation, and classification. DC motor - working principle, torque equation, types, characteristics, speed control of DC motor, starting methods and stepper motors. (problems to be included)	12
02	Transformers: Single phase and three phase transformers: Working principles and testing methods. Efficiency regulation. Equivalent circuits.(Problems to be included)	08
03	Integrated Circuits and Devices: Operational Amplifiers, ~ basics, ideas OP-AMP ratings, OP-AMP applications, linear and digital IC's, counters, registers, multiplexers, de multiplexers, decoder and encoder.	10

04	Solid State Controls and Applications: Timers and relays, applications of Silicon Controlled Rectifiers (SCR) in control of DC & AC motor, resistance-welding (welding control with solid-state circuits (elaboration is needed from application point of view).	10
05	Microprocessors and Applications: Memory systems, Microprocessor (only 8085 Architecture and instructions), programmable controllers, regulation of voltage and motor speed (microprocessor based, block diagram and flow chart approach only)	08

Practicals:

- Characteristics of 3-Phase Induction motor.
- DC Motor characteristics.
- Speed control of DC Motors.
- Study of counters.
- Application of timers.
- SCR application in AC and DC Motors.
- Micro processor programming (simple programmes without any interfacing circuits).
- Study of PLC.
- Balanced three phase power measurement using transformers.

Term work:

- At least one class test must be conducted in the middle of the semester and 10 marks
- Weightage must be assigned to it during the evaluation of the term work.
- Report on laboratory experiments based on the above chapters, and at least 8
- Experiments must be conducted from the list given above in the list of experiments.
- At least 5 assignments consisting of minimum 5 problems in each assignment from
- Among the 6 chapters must be submitted along with the laboratory report and the test papers.

References:

- Electronic Devices and Circuit Theory by Boylestad & Nashelsky
- Electric Machines and Transformers by Anderson Leonard and Jack Macneil
- OP-Amplifier by Gayakwad
- Microprocessor by Gaonkar
- Digital Principles & Applications by Malvino & Leach
- SCR by G.E. Mamal
- Electrical Technology by Cotton.
- Electrical Machines by M.G. Say

University of Mumbai

COURSE: (PRODUCTION ENGINEERING)

Semester-IV

SUBJECT: THERMAL ENGINEERING (P)

Periods per week
of Period of 60 min

Lecture 5
Practical 2
Tutorial -

Evaluation System

	Hours	Marks
Theory Examination	3	100
Practical Examination	-	25
Oral Examination	-	-
Term Work	-	25
Total		150

Objective
This is an allied discipline to prepare a theoretical base for general understanding and application in production engineering.

Approach
This is based on concepts, principles and analytical treatment supplemented by problem solving.

Weightage
Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

No.	Details	Hrs
1	Revision of Thermodynamics concepts: System, surrounding, state path property Reversible and irreversible process thermodynamic work, heat, Temperature, thermal equilibrium, Zeroth law of thermodynamics.	02
	First law of thermodynamics: Joule's experiment to verify first law, First law applied to non-cyclic process Internal energy as a property, Joule's experiment of internal energy, Equation of state of ideal gas. Universal and specific gas constant. Application of First law to non flow processes, viz., constant volume, constant pressure, constant temperature, adiabatic and polytropic processes, heat and work calculations.	06

03	First law of thermodynamics applied to flow processes : Flow, work, enthalpy, control volume. Application of first law to open system. Steady flow energy equation. Throttling process Joule's porous plug experiment, Joule Thomson's coefficient. Work done in steady flow processes in terms of pressure and volume. Application to boiler, nozzle, condenser etc.	05
04	Second law of thermodynamics : Limitations of first law of thermodynamics. Heat engine, thermal efficiency, reversed heat engine, coefficient of performance, Carnot cycle. Kelvin-Planck and Clausius statements and their equivalence. Perpetual motion machines of first and second kind. Carnot's theorem. Thermodynamic temperature scale. Entropy: Clausius inequality. Entropy, temperature - entropy diagrams. Entropy changes for an ideal gas during reversible processes.	07
05	Analysis of I.C. Engines: Otto, Diesel and dual combustion cycles, air standard efficiency and mean effective pressure, study of constructional details of I.C. Engines. Four stroke and two stroke cycle I.C. engines, S.I. and C.I. engines. Study of simple carburetor, fuel pump, fuel injector and nozzle of I.C. engines. Cooling and lubrication systems of I.C. engines. Ignition system of S.I. engines. Governing of I.C. engines. Valve timing diagrams. Calculation of I.P., F.P. and S.P., determination of indicated and brake thermal efficiency and specific fuel consumption. Testing of I.C. engines. Heat-balance sheet.	05
06	Air compressors : Uses of compressed air, classification, single stage reciprocating air compressor without clearance. Work and power calculation, isothermal and adiabatic efficiency, two stage air compressor with perfect inter cooling. Ideal intercooler pressure, F.A.D. and volumetric efficiency. Effect of clearance volume.	04
07	Gas Turbines : Advantages and disadvantages of gas turbines. Constant pressure Joule cycle with isentropic and irreversible adiabatic expansion. Open cycle gas turbine, work, power and thermal efficiency. Closed cycle gas turbine, constant volume cycle gas turbine.	05
08	Heat Transfer : One dimensional, steady state, heat transfer by conduction through plane wall, radial heat transfer by conducting through hollow cylinder and hollow sphere. Conduction through a composite plane and cylindrical wall. Heat flow by convection. Free and forced convection. Nusselt, Reynold and Prandtl number; heat transfer between two fluids separated by composite plane and cylindrical wall. Over all heat transfer coefficient. Heat exchangers. Types of heat exchangers. Log Mean Temperature difference. Wien's law, Stefan Boltzman's and Kirchoffs laws.(problems & derivations to be cut down) Problems based on LMTD only in which overall heat transfer coefficient to be given.	08

Refrigeration and Air Conditioning: Applications of refrigeration, relative c.o.p. and ton of refrigeration, air refrigeration, Sell Coleman cycle or PV and T.S. diagram, c.o.p and power calculations. Vapour compression refrigeration system. Representation on T-S. and P-H diagram. CO P, power, capacity and mass flow rate calculation effects of sub cooling, vapour absorption system of refrigeration. Desirable properties of an idea refrigerant. Comparison of ammonia, SO₂, CO₂. Freon (R-11 and R-22) as refrigerants. Study of domestic refrigerator and water cooler. Central air condition system, study of window air conditioner and package air conditioner.

08

Term Work:

- 1) Report on laboratory experiments based on the above chapters. At least 6 experiments are to be conducted.
- 2) At least five assignments comprising of minimum 5 problems in each assignment must be submitted along with the laboratory reports from among the above 6 chapters.
- 3) At least one class test must be conducted at the middle of the semester and 10 marks weightage must be assigned for the evaluation of test in the term work.
- 4) The final report should contain all of the above as shown in 1, 2 and 3.

References:

- 1) Thermal engineering by R K. Rajput, Laxmi Publication
- 2) A course in Thermal engineering by Domkundwar, Kothandaraman and Khajuria, Dhanatrai Publication
- 3) Engineering Thermodynamics by P K. Nag, Tata McGraw Hill Publishers
- 4) Engineering Thermodynamics by G.F.C Rogers, Y.R Mayhew, ELBS/Longman Publication
- 5) Thermodynamics and Heat Engines. Volume 1 by R. Yadav, Central Public House, Reprint 1992.
- 6) Thermodynamics for Engineers by M.L. Mathur and S.C.Gupta, Jain Brothers
- 7) Thermal Engineering by Ballanne, Khanna Publishers.

University of Mumbai

C.A.S.S.E. (PRODUCTION ENGINEERING)

Semester-IV

SUBJECT: ENGINEERING DESIGN (P)

Periods per week
01 Period of 60 min

Lecture 4
Practical 2
Tutorial -

Evaluation System

Theory Examination

Hours

Marks

4

100

Practical Examination

-

-

Oral Examination

-

-

Term Work

-

25

Total

125

Objective

To impart knowledge of analysis & design of various machine elements for function, reliability, safety, standardization & aesthetics.

Approach

Equal emphasis on concepts and problem solving. Design data handbook is not allowed during examination. relevant data must be given in the question paper.

Weightage

Details of Syllabus

Sr. No.	Details	Hrs
01	Introduction Steps involved in designing, types of designs, considerations in designing, Design-manufacturing interface, material selection, factor of safety and its implications.	03
02	Operational Joints : Introduction, strength of joints: cotter joints, knuckle joints, sleeve type cotter joint, gib and cotter joint, pinned joints, turn buckle	06
03	Shafts, keys, Couplings and Pulleys: Shafts subjected to axial loads, twisting and bending moments, design of keys, Muff coupling, flange couplings, bushed pin type flexible coupling, marine type coupling. Design of flat and V-belt pulleys.	08

Machine Elements :

Machine parts subjected to direct and eccentric loading, finding area of cross section of machine members of frames having following cross section-Circular, rectangular, box, square, triangular, T, I and trapezoidal sections only. design of rivets or bolts subjected to eccentric loading on the above types of frame fastenings.

06

Curved Member and Crane Hooks :

Having following cross section only: Circular, triangular, square, rectangular, trapezoidal (Circular rings and chain links are excluded).

04

Gear Wheels: Design of spur gears, simple gears calculation, design of gears based on beam strength and wear/ Lewis and Buckingham's equation.

04

Design of columns/struts subjected to buckling: Design of connecting rod

03

Design of Springs:

Classification and applications, design of helical, compression and tension springs, co-axial springs, Design of leaf springs-straight and laminated and semi elliptical, Strain energy of springs- design of buffer springs.

06

Riveted Joints :

Design of joints subjected to eccentric loading, Boiler joints, longitudinal and circumferential joints, single riveted, double riveted and triple riveted joints having equal/unequal cover straps, chain and zigzag riveted arrangements, use of Indian Boiler Regulation (IBR) in design.

03

Design of welded joints:

Strength of welded joints, welded joints subjected to eccentric loads, special cases of welded joints

03

Pressure Vessels :

Thick and compound cylinders, determination of wall thickness of cylinders, hoop and radial stresses, plotting hoop and radial stress distribution curves.

03

Term work:

- 1) Design and preparation of production of simple assemblies based on the syllabus contents. (At least 6 exercises) drawings in each chapters and the drawing are to be drawn on half imperial drawing sheets for the designed dimensions using conventional standards.
- 2) Assignments consisting of four problems from the chapters shown in the detailed syllabus, excluding the ones selected for design and drawing.

- 3) Atone class test must be conducted at the middle of the semester and weightage of 10 marks must be assigned for this test will evaluating the term work.
- 4) The final term work report consists of the assignment as shown in 1 and 2 and the test paper as shown in 3 above.

References:

- 1) Elements of machine Design by N. C. Pande and C. S. Shah
- 2) Design of machine elements by M. F. Spotts
- 3) Engineering Design by Schaum's Series
- 4) Engineering Design by Keal Pujara
- 5) Engineering Design by Black
- 6) Engineering Design by Patel
- 7) Machine design by R. K. Jain
- 8) Machine design by J. E. Taylor and J. S. Wringley

University of Mumbai

CLASS: S.E. (PRODUCTION ENGINEERING)

Semester-IV

SUBJECT: WORKSHOP PRACTICE IV (P)

Periods per week
01 Period of 60 min

Lecture -
Practical 3
Tutorial -

Evaluation System

Theory Examination

Hours

Marks

Practical Examination

Oral Examination

Term Work

Total

-

3

-

-

-

-

-

-

-

50

-

50

100

Objective

In continuation of the subject in earlier semesters develop procedural and manual skills in planning the resources and producing a complete end product

Approach

Training in identification of resources, constraints and organizing for the work to meet quantity, quality and delivery date requirements.

Weightage

Proportional to the number of 'Hrs' indicated in the right column below.

Details of Syllabus

Sr. No.	Details	Hrs
01	MACHINE SHOP One composite job consisting of minimum four parts employing operations on lathe, viz. precision turning, screw cutting, boring etc. and involving use of shaping, milling, drilling and grinding (cylindrical/surface) operations. Standard additional parts like screws, rivets, springs, dowels, circlip, etc., may be used if required.	24
02	Assembly and disassembly of some of machining fixture, drill jig etc.	06
03	Assembly and disassembly of machine tool sub assembly	06

Term Work:

Should contain the jobs done as shown in sl nos. 1, 2 & 3 above of the detailed syllabus.

Practical Examination:

Practical examination will be held for 4 hours only and shall consist of preparation of jobs in precision turning, boring, screw cutting, drilling, milling, shaping, grinding, etc.

— X — X —