guidelines for instructors

Masterplan-curriculum for apprentices & trainees

metal trades

T.T.P. SERIES 38

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DEVELOPMENT CELL
FOR SKILLED LABOUR TRAINING
DIRECTORATE OF MANPOWER & TRAINING
GOVERNMENT OF THE PUNJAB
LAHORE

masterplan–curriculum

for

imparting theory instructions

to

apprentices and trainees

turner & machinist

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CONTENTS

I N T R O D U C T I O N

With a view to standardizing skilled labour training, functioning under the aegis of the DIRECTORATE OF MANPOWER & TRAINING, PUNJAB, LAHORE, a Development Cell has been set up at this Directorate under the Pak-German Technical Assistance Programme. One of the activities of the Development Cell is to prepare standardized "Training Courses" for various trades.

Skilled manpower is the backbone of industry. Industrial progress is not possible without the availability of systematically trained skilled personnel. The trade proficiency of such a skilled workman does not only depend upon his skills but also upon the knowledge of when and how to apply these skills in any situation that may arise while working on the job. Therefore, a sound understanding of materials, tools, appliances and working methods is a must for every systematically trained skilled workman and the training programme has to fulfil this requirement.

Although skilled workmen must gain broad background information about their respective trades during the course of training, that does not mean they should be imparted highly scientific theory as for engineers and technicians. Practical work is the prime objective in skilled labour training and theoretical knowledge is required to a lesser extent. As such 80 % of the training period is devoted to practical work and 20 % to theoretical instructions.

The Development Cell has therefore prepared the "Masterplan Curriculum" in the subjects of Technology, Technical Mathematics and Technical Drawing for imparting theoretical instructions to apprentices and trainees in the Turner & Machinist trades.

SET-UP OF THE MASTERPLAN CURRICULUM

The Masterplan Curriculum for Turners & Machinists covers all the necessary requirements for imparting theoretical instructions to apprentices and trainees in their respective trade. It can be utilized in all training institutions where related theoretical instructions are imparted to apprentices and trainees.

The curriculum has been split up in three main subjects namely Technology, Technical Mathematics and Technical Drawing. These subjects have been divided into units and sub-units. Within each sub-unit, topics are specified which show the contents of the lesson to be taught. This will help the instructors to understand the scope of the lesson.

Technology is the main subject; the other subjects deal with the related aspects of Technology on the same teaching day. An extract form the Masterplan Curriculum is shown below as an example of these parallel activities:

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHN. DRAWING
13	ISO-FITS AND TOLERANCES		
13.1	WT Fits and Tolerances -necessity of fits (mass production, interchangeability of parts) -basic definitions (nominal size, actual size, limits of size, zero line, tolerance) -types of fits-clearance, interference and transition	Calculation of Fits -basic definitions and expressing fits on hole and shaft -meaning of symbols	Rectangular Cuts I -prisms with triangular base (Sheet No. 50)
13.2	WT Fits and Tolerances -maximum/minimum clearance and interference -tolerance zone (grade & position) -fit systems (basic hole/basic shaft)	Calculation of Fits -calculating fit dimensions for hole and shaft (max./min. sizes, off-sizes)	

Every sub-unit has a common serial number for the three subjects namely Technology, Technical Mathematics and Technical Drawing. One sub-unit is to be taught in one day. One day per week with (50 minutes each) lesson-periods may be followed for imparting theoretical instructions. The break-up of the lesson-periods is as follows:

3 lesson-periods for Technology
2 lesson-periods for Technical Mathematics
and 2 lesson-periods for Technical Drawing.

HOW TO USE THE MASTERPLAN CURRICULUM FOR THE APPRENTICE TRAINING SCHEME

Under the Apprentice Training Scheme the duration of training for Turners and Machinists is 3 years. This training duration has been divided into 6 periods/semesters. The theoretical instructions may be arranged on a Day Release Basis throughout the period of training. The Block Release System may also be followed which provides about 150 days (25 weeks) with 7 lesson periods (50 minutes each) per day for imparting theory.

The programme of theoretical instructions for apprentices of Turner and Machinist trades is broadly divided into three parts namely i) Fundamentals of Metal Trades
ii) Trade Theory (Turners and Machinists)
and iii) Projects (applied theory).

During the 1st and 2nd semesters a common course "Fundamentals of Metal Trades" is to be taught. This covers units 1-12 of the Masterplan Curriculum.

During the 3rd semester a common course in Trade Theory for Turners and Machinists is to be taught. This course mainly covers the common basic Machine Tools Operations and is spread over units 13-17.

During the 4th semester theoretical instructions in respective trades are to be imparted. This facilitates to impart specific trade knowledge in the trade and covers units 18-20 for Turners and units 18-22 for Machinists.

During the programme of training from 1st to 4th semester, the trade theory is imparted in the subjects Technology, Technical Mathematics and Technical Drawing.
Emphasis has been given to maintain parallelity in imparting the theoretical instructions and the practical training in the workshop. With this view point the Trade Theory of some common basic Machine Tools Operations for example Milling, Shaping, Turning, Grinding, have been placed in the 3rd semester.

During the 5th and 6th semesters emphasis is given to apply the Trade Theory learnt during the first four semesters. Trade Theory is not imparted separately in the subjects of Technology, Technical Mathematics and Technical Drawing. With this view point 12 Theory Projects have been designed for the Turner and Machinist trades (see pages 57 to 60). The questions for each project are prepared keeping in view the following:

i) Purpose of the project (technical and economical instructions)
ii) Representation, design and application
iii) Function of the project
iv) Materials and tools
v) Manufacturing problems
vi) Sequence of operations
vii) Measuring and checking techniques
viii) Related calculations

At the end of each semester 1 week is provided for test.

The time schedule to be followed for imparting theoretical instructions is shown on page No. 7.

MASTERPLAN CURRICULUM

TIME SCHEDULE FOR APPRENTICE TRAINING SCHEME

	I st YEAR					II nd YEAR					III rd YEAR				
	1 st SEMESTER			2 nd SEMESTER		3 rd SEMESTER		4 th SEMESTER			5 th SEMESTER		6 th SEMESTER		
WEEK	1 - 23	24	25	1 - 24	25	1 - 24	25	1 - 23	24	25	1 - 24	25	1 - 23	24	25
TRADE THEORY	FUNDAMENTALS OF METAL TRADES	REVIEW	TEST	FUNDAMENTALS OF METAL TRADES	TEST	TRADE THEORY (TURNERS & MACHINISTS)	TEST	TRADE THEORY (TURNERS & MACHINISTS)	REVIEW	TEST	PROJECTS (APPLIED THEORY)	TEST	PROJECTS (APPLIED THEORY)	REVIEW	TEST
UNIT NO.	1 - 6			7 - 12		13 - 17		TURNERS 18 - 20 MACHIN. 18 - 22			PROJECTS 1 - 6		PROJECTS 7 - 12		

HOW TO USE THE MASTERPLAN CURRICULUM FOR THE TECHNICAL TRAINING SCHEME

Under the Technical Training Scheme the duration of training for Turners and Machinists is 2 years. This training period has been divided into 4 periods/semesters. The theoretical instructions may be arranged on a Day Release Basis throughout the period of training. The programme of theoretical instructions is broadly divided into 3 parts namely

i) Fundamentals of Metal Trades
ii) Trade Theory (Turners and Machinists)
and iii) Trade Theory (Turners and Machinists).

During the 1st and 2nd semesters a common course in Fundamentals of Metal Trades is to be taught. This covers units 1-12. During the 3rd semester a common course in Trade Theory is designed which mostly covers the common basic Machine Tools Operations such as Milling, Turning, Shaping and Grinding. This covers units 13-17.

During the 4th semester Trade Theory is imparted in the respective trade. This covers units 18-20 for Turner trade and units 18-22 for Machinist trade.

Turner and Machinist trades are grouped together in the first three semesters and a common course is designed for imparting the theoretical instructions, whereas the respective Trade Theory shall be imparted to Turners and Machinists during the 4th semester. This has been done to facilitate the centre administration for making suitable arrangements for imparting theoretical instructions. However, emphasis has been given to maintain the parallelity in the imparting of theoretical instructions and practical skill.

Throughout the training programme Trade Theory is imparted in the subjects of Technology, Technical Mathematics and Technical Drawing.
At the end of each semester 1 week is provided for test.
The time schedule to be followed for imparting theoretical instructions is shown on page No. 9.

MASTERPLAN CURRICULUM

TIME SCHEDULE FOR TECHNICAL TRAINING SCHEME

	I st YEAR					II nd YEAR				
	1 st SEMESTER			2 nd SEMESTER		3 rd SEMESTER		4 th SEMESTER		
WEEK	1 - 23	24	25	1 - 24	25	1 - 24	25	1 - 23	24	25
TRADE THEORY DAY RELEASE BASIS	FUNDAMENTALS OF METAL TRADES	REVIEW	TEST	FUNDAMENTALS OF METAL TRADES	TEST	TRADE THEORY (TURNERS & MACHINISTS)	TEST	TRADE THEORY (TURNERS & MACHINISTS)	REVIEW	TEST
UNIT NO.	1 - 6			7 - 12		13 - 17		TURNERS 18 - 21 MACHINISTS 18 - 22		

BOOKS AND MANUALS

Text Books

1. Gerling	-	"Machine Tools Say Mutallaqa" (Urdu Edition) Ferozsons Ltd. Lahore for: Development Cell for Skilled Labour Trg.
2. Bendix	-	"Ibtedai Dhat Kari" (Urdu Edition) National Book Foundation for: Development Cell for Skilled Labour Trg.
3. Minhas	-	"Tekneeki Reyazi" National Book Foundation for: Development Cell for Skilled Labour Trg.
4. Development Cell	-	"Technical Drawing for Metal Trades" Book 1 and 2 Development Cell for Skilled Labour Trg.
5. Jütz-Schrkus	-	"Westermann Tables for Metal Trades" Development Cell for Skilled Labour Trg.

Instructor Manuals

1. Development Cell	-	"Solution Book Technical Drawing for Metal Trades" Book 1 and 2 Development Cell for Skilled Labour Trg.
2. Minhas	-	"Solution Book Tekneeki Reyazi for Metal Trades" Development Cell for Skilled Labour Trg.

MASTERPLAN - CURRICULUM

FUNDAMENTALS OF METAL TRADES

Unit No.	TECHNOLOGY (including Working Techniques (WT) Materials (M) and Science (S)	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
1	INTRODUCTION			
1.1	WT Workshop, Workplace, Tools -order of workplace -maintenance and storing of tools -costs of machines, tools, materials -introduction to general tools used in the metal workshop; their care and proper use M Basic Characteristics of Metals -metals / non-metals -pure and alloyed metals -ferrous / non-ferrous metals -base metals	Whole Numbers -addition and subtraction	Introduction to Technical Drawing -kinds of lines -drawing instruments	1
1.2	WT Workshop, Workplace, Tools -safety precautions M Important Metals -use of grey cast iron and steel -important non-ferrous metals and their use S Power -muscular power -machine power -sources of power -important prime-movers	Whole Numbers -multiplication and division	Introduction to Technical Drawing -lettering exercises	2,3

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
2	MEASURING I			
2.1	WT General Introduction -purpose of measuring -accuracy of measuring -linear measuring (steel rule, calipers, vernier calipers) S Units -units of length (metric) -units of angles	Fractions -addition, subtraction of common fractions	Views of Prismatic Work-pieces I -representation in cavalier projection	4,5
2.2	WT Steel Rules -types and use of different steel rules and steel taps Calipers -inside/outside calipers (construction and use) -transferring measurements and reading on rules S Types of Motion -linear motion -rotary motion -measuring of motion (velocity)	Fractions -proper fractions, improper fractions and mixed numbers -multiplication and division of fractions	Views of Prismatic Work-pieces I -representation in 3 views	6,7, 8,9

2.3	WT Vernier Calipers (inside, outside, depth) -accuracy of reading (metric) -principle of vernier scale -measuring faults Angle Measuring Instruments -measuring with angle measuring instruments (fixed/adjustable)	Decimal System of Measurement -metre, gram, litre	Views of Prismatic Workpieces I -assembling bodies recognition of views	10,11 11A
2.4	WT Care and Maintenance of Measuring Instruments Gauges -purpose and use of thread gauges and feeler gauges	Decimal System of Measurement -multiples and parts of units	Views of Prismatic Workpieces I -completion of views, visible edges	12

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
3	HAND-OPERATION TECHNIQUES I			
3.1	WT Marking -necessity of marking -common marking tools (scriber, steel rule, centre punch, marking block, vernier height gauge, centric gauge, centring bell) -marking with common marking tools -care and maintenance of marking tools M Properties of Materials -elementary metals - alloys -crystal structure of metals S Force -effects of force -forces acting at the cutting edge of the tool	Decimal Fractions -addition, subtraction	Prismatic Workpieces II Dimensioning -workpieces with covered edges	13,14, 15
3.2	WT Chipping and Cutting by Hand Sawing -cutting principle (rake angle) -the saw blade (pitch of teeth, setting of teeth and tightening the blade in the frame) -sawing of pipes and sheets M Properties of Materials -hardness of materials -effect of hardness	Decimal Fractions -multiplication, division	Prismatic Workpieces II Dimensioning -entry of dimensions	14,15

3.3	WT Chiselling -purpose of chiselling and its principle -types of chisels and their use -cutting effect of the wedge -chiselling faults and the prevention of accidents S Force -measuring of force and its representation -cutting action of forces	Conversion of Inch to Metric System -equivalent of one inch in mm -conversion of dimensions	Prismatic Workpieces II Dimensioning -drawing true to scale	16,17
3.4	WT Shearing -shearing with hand shears and shearing machines -types of hand shears and their working S Force -forces at levers -lever and its principle -lever in balance	Percentages -meaning of percentage -changing numbers to percents -changing percents to decimal and common fractions	Prismatic Workpieces II Dimensioning -drawing of radii	19

3.5	WT Filing -process of filing -shape of cuts -types of files with regards to cuts and shapes M Properties of Materials -cohesive force in materials (cohesion) -cohesiveness of materials S Strength -tensile/compressive strength	Percentages -finding the rate, the base, the percentage	Prismatic Workpieces II Dimensioning -inclined surfaces	19
3.6	WT Scraping -scraping process -principle of scraping tools (rake angle) -scraping tools and their use Making Holes with -punching tools, punching pliers and press punches S Friction Cutting Force and Cutting Resistance	Revision / Test	Cylindrical Workpieces -centre lines, dimensioning -drawing in less than three views	19 19

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
4	MACHINE-OPERATION TECHNIQUES I			
4.1	WT Drilling, Countersinking -drilling of through holes (effect of movements of the drill, cutting process) -types of twist drills, main parts (their names and functions) H Lubricants and Coolants -necessity of cooling/lubricating -cutting fluids/lubricants	Angles -angle and its units (degree, minute, second) -types of angles (acute, right, obtuse, straight, reflex, full)	Surface Symbols -purpose of surface symbols -entr of surface symbols	20 20,21
4.2	WT Drilling, Countersinking -angles at the twist drill (rake, cutting lip and clearance angles) their effects, grinding of drills -countersinking-tools, purpose and procedure S Rotary Motion -number of Rpm -effect of Rpm on the drills -clockwise and anticlockwise rotary motions	Angles -calculation of angles (addition, subtraction, mulitplication, division)	Surface Symbols -assembly of two parts	22

4.3	WT Drilling and Countersinking -operation and function of hand drilling machine and power drilling machine -clamping and removing of twist drills -drilling faults	Angles -expressing values of angles in decimal form (conversion from degrees, minutes and seconds into decimal and vice versa)	Repetition and Respective Exercises	22
4.4	WT Reaming -purpose and process of reaming -types of reamers (hand reamers, machine reamers, adjustable reamers) -angles at the cutting edge	Tolerances -calculation of nominal, max. and min. sizes, actual size)	Tolerances -measuring of nominal size, max. and min. sizes, actual size, lower and upper off-sizes tolerance	23

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
5	HAND-OPERATION TECHNIQUES II			
5.1	WT Bending -bending process and bending effect (neutral fibre of flat and round workpieces, extended length) M Effect of Forces on Material -effect of compressive and tensile forces on material -ductility and toughness S Forces -tensile and compressive forces -change of structure under these forces	Surface Area I -surface area of rectilinear plane engineering figures (square, rectangle, trapezium)	Tolerances -entry of tolerances -assembly of three parts	23,24
5.2	WT Bending -bending tools and devices -bending machines -bending of bases, pipes and sheets with hand and machines S Importance of Fibre and its Direction	Surface Area I -surface area of rectilinear plane engineering figures (rhombus, parallelogram, triangle)	Reference Edges and Faces -laying out workpieces considering reference edges -dimensioning according to the sequence of operation	25,26

5.3	WT Hammering and Straightening -process of hammering and straightening -stretching and upsetting effect M Properties of Material -extensibility and malleability S Energy -potential and kinetic energy	Surface Area II -surface area of angular plane engineering figures (circle, sector of a circle)	Drawing from Models -angle support -bolt with square	27
5.4	WT Hammering and Straightening -straightening of bases -clamping of sheets -care and handling of tools S Motion -swinging motions	Surface Area I and II -practice of solving different problems	Drawing from Models -plumber block -lever	28

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
6 6.1	FASTENING METHODS I (TEMPORARY) WT Joining of Parts with Screws -screwing procedure -characteristics of a thread S Motion and Forces at Threads	Use of Tables -calculating the area of rectilinear and angular plane engineering figures from tables	Drawing from Models -repetition and additional exercises	27,28
6.2	WT Joining of Parts with Screws -types of screws, bolts and nuts -standardization of threads -sizes of screws, bolts and nuts S Force -representation of forces on a thread by means of drawing (inclined plane with screw jack example)	Use of Tables -practice of solving other problems with the use of tables	Pyramidical and Conical Workpieces -representation	29
6.3	WT Joining of Parts with Screws -thread cutting tools -tightening of screws, -locking of screws against loosening (check nuts, slotted nuts, cotter pin, spring lock washers, safety tap washers) -revision	Surface Area I and II -workshop calculation practice	Pyramidical and Conical Workpieces -recognition	30
	Review	Review	Review	

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
7	HAND-OPERATION TECHNIQUES III			
7.1	WT Thread Cutting by Hand -method of cutting thread (internal and external) -taps, dies, dies for pipe threads M Properties of Material -toughness -reaction of tough material while cutting threads S Moment -turning moment	Square Root -method of evolving of square root	Pyramidical and Conical Workpieces -dimensioning	29
7.2	WT Thread Cutting by Hand -clamping of taps and dies -selection of core and outside dia S Work -principle of work	Transposition of Formulae -formulas -meaning of transposition (comparison with balance)	Pyramidical and Conical Workpieces -dimensioning	29,31
7.3	WT Thread Cutting by Hand -cutting, measuring and checking of threads S Work -work done while cutting thread	Transposition of Formulae -using multiplication and/or division signs	Pyramidical and Conical Workpieces -dimensioning	32

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
8 8.1	FASTENING METHOD II (PERMANENT) WT Riveting -process of riveting -effects of upsetting S Force -forces acting at rivet joints	Transposition of Formulae -using addition and/or subtraction signs	Sections I -full section	33
8.2	WT Riveting -rivets and their standardization (common rivets and their shapes) -types of riveting joints S Safety Stress and Strength of Material	Pythagorean Proposition -definition -derivation of formulae -practice of solving problems	Sections I -full section	34
8.3	WT Riveting -riveting tools -preparation of rivet joints -selections of rivets, upsetting of rivet head	Surface Area II -calculating area of composed figures	Sections I -full section (two views)	35

8.4	WT Soldering and Brazing -process of soldering and brazing -penetration of solder into the materials M Solder -solder and its standardization	Surface Area II -calculating perimeter of composed figures	Representation of Threads -external thread	36
8.5	WT Soldering and Brazing -heating devices for soldering and brazing -soldering tools -soldering/brazing of workpieces (preparation of workpieces) S Heat -transfer of heat (conduction and radiation)	Volumes -volume and units of volume	Representation of Threads -internal thread	37
8.6	WT Soldering and Brazing -care and prevention of accidents -soldering and brazing faults S Heat -amount of heat	Volumes -volumes of parallel engineering solids	Representation of Threads -screw joints	38

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
9	HAND-OPERATION TECHNIQUES IV			
9.1	WT Forging by Hand -forging process -upsetting of material -fire required, purging S Energy -kinetic energy	Volumes -volumes of cones and frustum of cone	Representation of Threads -screw joints	39
9.2	WT Forging by Hand -forging tools (anvil, swage block, hammers, tongs) -handling of fire S Burning Process	Volumes -volumes of pyramids and frustum of pyramid	Sections II -half sections	40
9.3	WT Forging by Hand -selection and blowing of hammers -cutting the material of the job -drawing down, upsetting, bending and punching	Volumes -volume of composed engineering solids	Sections II -off-set sections	41

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
10	FASTENING METHODS III (PERMANENT)			
10.1	WT Gas Welding -welding process -melting and solidification process S Gases -behaviour of gases -air pressure	Quantity of Liquids -units of quantity -calculating quantity of liquid in containers	Sections II -off-set sections	42
10.2	WT Gas Welding -welding equipments (torch, acetylene gas generator, gas cylinders, oxygen and acetylene) S Gases	Volume and Quantity -practice of solving the problems about volume and quantity	Sections II -parts not to be sectioned	43
10.3	WT Gas Welding -burning of torch (zones of welding flames) -blowing off the torch -preparing the job - welded joints -proper handling of the torch	Weight -weight and its units -specific gravity	Sections II -parts not to be sectioned	44

10.4	WT Electric Welding -process of electric welding -movement of electric arc M Heating Effect on Materials -expansion and shrinkage of materials S Electric Circuit	Weight -calculating weight on the basis of volume	Welded Joints -welding symbols	45
10.5	WT Electric Welding -welding equipment (welding transformer, electrodes, gloves, shields) S Heating and Lightning Effect of Electric Current	Weight -calculating the weight on the basis of length and area	Welded Joints -welding symbols	45
10.6	WT Electric Welding -voltage - selection of electrodes -testing of welded joints	Weight -practice of solving the problems	Welded Joints -welded joints (flywheel)	46

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
11	IRON AND STEEL			
11.1	WT Iron -production of pig iron -iron ore -blast furnace (construction, burning process) -products of the blast furnace (grey cast iron, white cast iron, slag, waste gases)	Estimation and Wastage -estimation -wastage	Welded Joints -welded joints (structural shapes)	47
11.2	WT Steel -production of steel and high grade steel from pig iron -purification of pig iron -methods of steel production (Bessemer converter, Thomas converter, Oxygen converter, Siemens-Martin process) -processes of Bessemer and Oxygen converters	Estimation and Wastage -calculating the wastage on the basis of volume	Welded Joints -welded joints (structural shapes)	47
11.3	WT Steel - Cast Iron -defects in material (during steel production) -production of high grade steel (electric arc furnace, electric induction furnace) -casted material -cast iron	Estimation and Wastage -calculating the wastage on the basis of area and length	Drawing from Models -welded structural shape	48

11.4	WT Steel - Cast Iron -malleable cast iron and cast steel -influence of alloying elements on steel and iron	Estimation and Wastage -practice of solving the problems regarding estimation and wastage	Drawing from Models -welded structural shapes	49
11.5	WT Steel - Iron -standardization of steel and iron -properties and uses of steel -structural steel -tool steel	Review	Drawing from Models -axle	49

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
12	NON-FERROUS METALS			
12.1	WT Heavy and Light Metals -non-ferrous heavy metals (copper, copper alloys, zinc, zinc alloys, tin, tin alloys, lead, lead alloys) -standardizing of non-ferrous heavy metals -non-ferrous light metals (magnesium, magnesium alloys, aluminium, aluminium alloys)	Review	Drawing from Models -axle	49

MASTERPLAN - CURRICULUM

TURNER / MACHINIST

Unit No.	TECHNOLOGY (including Working Techniques (WT) Materials (M) and Science (S)	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
13	ISO-FITS AND TOLERANCES			
13.1	WT Fits and Tolerances -necessity of fits (mass production, interchangeability of parts) -basic definitions (nominal size, actual size, limits of size, zero line, tolerance) -types of fits-clearance, interference and transition	Calculation of Fits -basic definitions and expressing fits on hole and shaft -meaning of symbols	Rectangular Cuts 1 -prisms with triangular base	50
13.2	WT Fits and Tolerances -maximum/minimum clearance and interference -tolerance zone (grade & position) -fit systems (basic hole/basic shaft)	Calculation of Fits -calculating fit dimensions for hole and shaft (max./min. sizes, off-sizes)		

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
14	TURNING OPERATIONS I			
14.1	WT Workpiece-Shapes-Technology -turning processes -turning lathes (different designs) -main parts of a centre lathe	Calculation of Fits -maximum / minimum clearance and interference	Rectangular Cuts I -prisms with hexagonal base	51
14.2	WT Workpiece-Shapes-Technology -main drive -belt and gear drives -stepped pully drive (with and without back gearing arrangement)	Elements of Mechanics Time -time and its units -expressing time in decimal form		
14.3	WT Workpiece-Shapes-Technology -gear box with variable speed gear -infinitely variable speed drives	Motion - Speed -types of motion -linear speed -rotary speed	Representation of Fits -meaning of fits	52
14.4	WT Workpiece-Shapes-Technology -feed gears (working mechanism i.e. working of apron, lead screw, locking mechanism, drop worm mechanism) -feed drives (belt feed drive, gear feed drive, Norton feed drive)	Cutting Speeds Linear Cutting Motion -calculating the cutting with linear cutting motion	Representation of Fits -types of fits	53

14.5	WT Workpiece-Shapes-Technology -turning tools, materials for turning tools -shape and angles of cutting edge M Steels -alloyed/unalloyed tool steels -high speed steel	Circumferential Cutting Motion -calculating the cutting speed with circumferential cutting motion	Representation of Fits -specification of fits	54

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
15	MACHINE OPERATION TECHNIQUES II			
15.1	WT Drilling -types of holes in different work-pieces -movements while drilling on the drilling machine -main parts of a drilling machine (drill spindle, main drive, feed drive, working table etc.) -different types and designs of drilling machines and their uses (column drilling machine, bench drilling machine, multi-spindle drilling machine, gang spindle drilling machine, radial drilling machine)	Drilling Calculations Speeds -calculating the cutting speed, the spindle speed (with formulas)	Rectangular Cuts II -pyramids	55
15.2	WT Drilling Tools -twist drill (shape, selection, advantages and care of a twist drill) -special drilling and boring tools (deep hole drill, centre bit, hollow drill, boring bars and cutting out tool), their shape and function -chucking of drill -selection of revolution and feed and cooling while drilling	Speeds -calculating spindle speed with the help of tables		

15.3	WT Drilling of Simple Holes on Drilling Machine -procedure -marking of drill holes -clamping of workpiece -operation layout -measuring of drilled holes	Feed -reading feed from table -calculating the rate of tool travel	Rectangular Cuts II -jobs with cut pyramids	55
15.4	WT Countersinking and Counterboring -procedure and purpose -counterboring with core drills -countersinking with rose bits -counterboring with centre bores and spot facer	Machining Time -calculating the time required for drilling a hole -calculating the total time		
15.5	WT Drilling of Smooth and Accurate Holes on the Drilling Machine Boring on the Lathe -procedure -measuring and testing -types and performance of reamers -reaming on the drilling machine -drilling, boring and reaming on the lathe (with example of manufacturing bushes) -testing and measuring techniques of bores	Shaping Calculations Cutting Speed -calculating the cutting speed for shaping	Representation of Key and Pin Joints -parallel and tapered keys	57

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
16	MACHINE OPERATION TECHNIQUES III			
16.1	WT Shaping and Planing -shaping machines (working of the machine, main motion, feed motion, main parts and their functions)	Length of Stroke / Numbers of Strokes -calculating the length of stroke -calculating the number of strokes per minute	Representation of Parallel Key -assembly drawing	57.1
16.2	WT Shaping and Planing -main drive, length of stroke, cutting speed, influence of length of stroke on cutting speed, feed drive -shaping and planing tools (shape and function) -clamping of tools	Milling Calculations Spindle Speed -calculating the spindle speed	Representation of Tapered Key -assembly drawing	57.2
16.3	WT Shaping and Planing -clamping of workpieces -setting the number of strokes per minute (from table), adjusting length of stroke, feed and cutting depth	Cutting Speed / Feed -calculating the cutting speed for milling -calculating the speed for milling cutters	Representation of Pins -cylindrical pins	58
16.4	WT Shaping and Planing -shaping of V-block (discussion on operation plan) -measuring and testing of V-blocks -design and working of planing machine -planing of Guide Gib (discussion on operation plan)	Cutting Speed / Feed -table for cutting speed and feed , use of table	Representation of Pins -jobs with cylindrical pins	58.1

16.5	WT Milling (Workpieces & Method) -features of workpieces prepared by milling -milling process -milling methods (plain & end milling, climb & conventional milling)	Trigonometric Ratios Concept -relation between angle and sides of a right angle triangle -trigonometric ratios (sin, cos and tan)		
16.6	WT Milling (Machines & Main Parts) -design and types of milling machines and their working (horizontal, vertical and universal milling machines) -main parts and their functions (milling spindle, main drive, feed drive etc.)	Trigonometric Table -reading the trigonometric table -practice of solving sums	Cuts on Cylinders -rectangular cuts on cylinders	59
16.7	WT Milling (Tools and Shape) -milling tools; types and function (milled tooth cutters - plain milling cutters and shell end mills, side milling cutters) -maintenance of milling tools	Inclination - Tapering Inclination -calculating inclination ratio, change in height, inclination angle (α)		
16.8	WT Milling (Mounting of Cutter and Clamping the Workpiece) -mounting of milling cutters (checking of concentric running and rules for mounting of cutters) -clamping of workpieces	Tapering -calculating bigger/ smaller diameter, setting angle ($\alpha/2$)	Cuts on Cylinders -penetration of cylinders	60

16.9	WT Milling (Operation) -selection of Rpm., feed -rough and finish milling -rules for milling -accident prevention -cooling during milling -milling of plane surfaces (discussion on operation plan and testing of the surface)	Inclination - Tapering -practice of solving sums		

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
17	GRINDING OPERATIONS			
17.1	WT Grinding and Grinding Wheels -purpose of grinding -composition of grinding wheels (types and selection of abrasives, selections of granulation) -bonding of the grinding wheels -bonding materials	Elements of Mechanics Strength -force and its units -force per unit area (pressure)	Cuts on Cylinders -job with cut cylinder	61
17.2	WT Grinding and Grinding Wheels -hardness of grinding wheels and selection of hardness -structure of grinding wheels -grinding wheels (shapes, maintenance & mounting) -rules for selection of grinding wheels -dressing of grinding wheels	Strength -calculating tensile strength	Assembled Workpieces -reading the drawing	62
17.3	WT Grinding and Grinding Wheels -circumferential speed of grinding wheel -sharpening of tools (machines for sharpening) -cutting speed and Rpm. of grinding wheels -rules for sharpening -fettling of workpiece -cooling during grinding and prevention of accidents	Strength -calculating shearing strength	Assembled Workpieces -preparation of detail drawing	63

MASTERPLAN - CURRICULUM

TURNER

Unit No.	TECHNOLOGY (including Working Techniques (WT) Materials (M) and Science (S)	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
18	TURNING OPERATIONS II			
18.1	WT Workpiece-Shapes-Technology -types of turning tools -maintenance/grinding of turning tools -clamping and setting of turning tools	Work -formula for calculating the work -work and its units	Representation of Gear I -denominations	64
18.2	WT Workpiece-Shapes-Technology -cutting speed (considering the material of workpiece/tools, cross-section of chips, cooling, design of machine) -spindle speed -reading Rpm from the cutting speed diagram -feed, depth of cut, types and shapes of chips	Work done in Rotation -formula for calculating the torque -solving the sums regarding work and torque	Representation of Gear II -symbols	65
18.3	WT Parallel Turning -reading drawing -turning operations (turning of bolt) -measuring and testing -chucking short cylindrical workpiece -rules for longitudinal turning -grooving and parting off -surface finishing symbols	Mechanical Power -formula for calculating the power -power and its units	Representation of Gear III -spur gear	66

18.4	WT Stepped Turning -reading the drawing -turning operations -measuring and testing of bolt with micrometer and depth gauge (procedure and care) -chucking of short cylindrical parts in collet chucks (collet chuck - internal and external stepped chucks)	Efficiency -power given (input) -power obtained (output) -formula for calculating the efficiency -solving sums regarding power and efficiency	Angular Cuts -on prisms	67

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
19	TURNING OPERATIONS III			
19.1	WT Turning of Shafts -shafts (purpose of various shafts) -turning operations -measuring and testing of shafts (caliper-snap gauge) M Hardening -process of hardening -quenching media S Force -effects of forces acting on a shaft	Transmission of Power Friction Drive -simple belt drive: calculating transmission ratio, diameters and Rpm of pulleys	Angular Cuts -on pyramids	68
19.2	WT Turning of Shafts -turning between centres -marking of the centres (with height scriber, centre gauge, dividers, centering bell) -drilling of centre holes M Surface Hardening -purpose (wear resistant surface, tough and ductile core) -process of case hardening (process in general, carborizers) -flame hardening	Friction Drive -double belt drives: calculating total transmission ratio, diameters and Rpm of pulleys	Turned Workpieces -internal and external recesses	69

19.3	WT Turning of Shafts -driving plates -fixed and steady rests (application) -turning on a lathe mandrel (purpose and types, ordinary and expanding mandrels) -straightening of shafts	Friction Drive -practice of solving sums		
19.4	WT Turning of Eccentric Shafts -eccentric shafts (purpose) -reading the drawing -chucking the job for off-centre turning -off-centre turning (marking procedure) -testing of off-centre sizes	Gears and Gear Drive -dimensions of a gear -formulas for calculating dimensions of a gear	Turned Workpieces -dimensioning according to machining process (turning I)	70
19.5	WT Profile Turning -profile turning (procedure) -rules for profile turning -profile tools -testing of profile with profile gauges	Gears and Gear Drive -calculating the centre to centre distance of gears	Turned Workpieces -dimensioning according to machining process (turning II)	70.1
19.6	WT Knurling -knurling workpieces (purpose) -knurling tools; diamond and straight knurling	Gears and Gear Drive -simple gear trains; calculating the transmission ratio (gear ratio)	Drilled Workpieces -dimensioning the jobs considering the production method and tools	71

19.7	WT Turning of Housings and Castings -marking -mounting the workpiece on the lathe (face plate) -measuring and testing of turned workpiece (cover) -aligning of workpiece on the face plate	Gears and Gear Drive -compound gear train; calculating the total transmission ratio	Drilled Workpieces -dimensioning the jobs for marking and drilling processes	72
19.8	WT Mass Production of Turned Parts -purpose of mass production -different machines -capstan lathe (introduction, procedure of manufacturing bolt on capstan lathe) -automatic lathes -tracer turning (copying turning)	Gears and Gear Drive -practice of solving sums	Milled Workpieces -dimensioning according to machining process	73.1

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
20	**TURNING OPERATIONS IV**			
20.1	WT Taper Turning -taper turning (internal and external) -designations on the taper -taper turning methods (compound slide, off-set, taper turning attachment)	Turning Calculations Cutting/Spindle Speeds -calculating cutting speed/spindle speed with formulas and table	Dimensioning -turning, milling and drilling processes	73
20.2	WT Taper Turning -setting of taper guide bar -rules for taper turning -manufacturing internal tapers -manufacturing of lathe centre (procedure, measuring, testing) -measuring and testing of angles	Feed/Depth of Cut -reading feed from the table -calculating the depth of cut and cross-sectional area of the chips	Drawing from Models -puller	74
20.3	WT Taper Turning -fixed and adjustable angle measuring instruments -testing of tapers (standardized) -manufacture of holes for taper pins	Cutting Speed -reading the cutting speed diagram		
20.4	WT Threads and Threading Operations -use of threaded parts -characteristics of threads (the pitch, direction of pitch, clamping effect of thread)	Rate of Tool Travel/ Machining Time -calculating the rate of tool travel -calculating the machining time	Drawing from Models -clamping device	75

20.5	WT Threads and Threading Operations -standardized threads (angular threads, metric threads, Whitworth pipe threads, armoured steel pipe threads, acme threads, buttress threads, round threads) -defects in threads	Taper Turning -terminologies -calculating off-set(when taper length equal/not equal to total length)		
20.6	WT Threads and Threading Operations -fits of threads -methods of manufacturing of threads (tap, die, threading tool, thread milling, thread grinding, thread rolling) -thread cutting operation on lathe and with tap and die (internal and external)	Taper Turning -calculations - when turning taper with compound slide		
20.7	WT Threads and Threading Operations -cutting of internal threads (with taps) on lathe machine (preparation of core hole, taps, selection of tap, cutting of thread, defective thread) -cutting of external threads (with dies) on lathe machine (preparation of bolt, selection of threading die, cutting of threads)	Change Gear Calculation Single Gearing -calculating the transmission ratio and suitable gears	Reading of Drawings I -dove-tail guide	76 76.1

20.8	WT Threads and Threading Operations -procedure of thread cutting on lathe -threading tools (shapes and functions)	Compound Gearings -calculating the transmission ratio and suitable sets of gears		
20.9	WT Threads and Threading Operations -function of the lead screw and split nut -function of change gears and feed mechanism -function of reversing gear	Thread Cutting Calculations -calculations when cutting inch threads with inch lead screw -calculations when cutting inch threads with metric lead screw		
20.10	WT Threads and Threading Operations -cutting of male threads with threading tool (procedure, measuring and testing) -cutting of female threads with threading tool (procedure, measuring and testing) -rules for thread cutting on the lathe -right-hand and left-hand threads -single and multi-start threads -mistakes during thread cutting	Thread Cutting Calculations -calculations when cutting metric threads with inch lead screw		
20.11	WT Threads and Threading Operations -thread cutting on capstan lathe -thread cutting on threading machine -thread milling (long and short) -thread finishing -thread grinding -thread rolling	Review	Review	

MASTERPLAN - CURRICULUM

MACHINIST

Unit No.	TECHNOLOGY (including Working Techniques (WT), Materials (M) and Science (S)	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
18	GRINDING OPERATIONS			
18.1	WT Cylindrical Grinding -external cylindrical grinding -cylindrical grinding machines (parts and their function) -external cylindrical grinding on lathe	Work -formula for calculating the work -work and its units	Representation of Gears I -denominations	64
18.2	WT Longitudinal Grinding -clamping of workpiece between centres -selection of the grinding wheel -cutting speed and Rpm of the grinding wheel -circumferential speed and Rpm of workpiece -depth of cut -grinding of shafts (discussion of operation plan and measuring and testing of shaft)	Work done in Rotation -formula for calculating the torque -solving the sums regarding work and torque	Representation of Gears II -symbols	65
18.3	Various Methods of Cylindrical Grinding -plunge-cut and profile grinding -taper grinding -centreless grinding -cut-off grinding -defects occurring during grinding	Mechanical Power -formula for calculating the power -power and its units	Representation of Gears III -spur gear	66

18.4	WT Internal Cylindrical Grinding -grinding methods -internal grinding machines (working and main parts) -clamping of workpieces -selection of grinding wheel -grinding of bores (discussion on the operation plan) -grinding of ring gauge	Efficiency -power given (input) -power obtained (output) -formula for calculating the efficiency -solving sums regarding power and efficiency	Angular Cuts -on prisms	67
18.5	WT Surface Grinding -rough and finish grinding -face and circumferential grinding -surface grinding machine for face grinding -face grinding (selection of wheel) -surface grinding machine for circumferential grinding -circumferential grinding (procedure and clamping of workpiece)	Transmission of Power Friction Drive -simple belt drive; calculating the transmission ratio, diameters and Rpm of pulleys	Angular Cuts -on pyramids	68
18.6	WT Surface Grinding/Fine Operation -grinding of parallels (discussion on operation plan and measuring and testing of parallels) -fine finishing operations (lapping - selection of the lapping compound, lapping methods, lapping by hand and with machines; honing; precision turning and precision boring)	Friction Drive -double belt drive; calculating the total transmission ratio, diameters and Rpm of pulleys	Turned Workpieces -internal and external recesses	69

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
19	MILLING AND MILLING OPERATIONS			
19.1	WT Milling Machines -repetition of horizontal, vertical and universal milling machines -other milling machines (plan of milling machine, thread milling machine, gear milling machine, copy milling machine)	Friction Drive -practice of solving sums		
19.2	WT Milling Tools -plain and end milling cutters (repetition) -milling cutters with shank (end mills, T-slot cutters, two lipped end mills) -form or profile milling cutters -face milling cutters with inserted teeth -form relieved cutters -gauge milling cutters	Gears and Gear Drive -dimensions of a gear -formulas for calculating dimensions of a gear	Turned Workpieces -dimensioning according to the machining process (turning I)	70
19.3	WT Milling Tools -discussion of reference values for number of teeth and angles on the cutting edge of the milling cutters -maintenance of tools (repetition) mounting of milling cutter and clamping of workpiece	Gears and Gear Drive -calculating the centre to centre distance of gears	Turned Workpieces -dimensioning according to the machining process (turning II)	70

19.4	WT Milling Plain Surfaces & Key Ways -milling of plane surface (repetition) (discussion on operation plan and method of testing of plane surfaces) -milling of keyways (discussion on operation plan and testing of keyways)	Gears and Gear Drive -simple gear train; calculating the transmission ratio (gear ratio)	Drilled Workpieces -dimensioning the job considering the production method and tools	71
19.5	WT Milling of Slides and Hexagons -milling of slides (discussion on operation plan and measuring and testing of slides) -milling of hexagons (discussion on operation plan and measuring and testing of hexagons)	Gears and Gear Drive -compound gear train; calculating the total transmission ratio	Drilled Workpieces -dimensioning the job for marking and drilling processes	72
19.6	WT Indexing -dividing with indexing attachment (plain indexing attachment, dividing head) -indexing with dividing head -differential indexing	Gears and Gear Drive -practice of solving sums	Milled Workpieces -dimensioning according to the machining process	73.1
19.7	WT How to Saw on a Milling Machine -slitting saws (shape, size and function) -selection of slitting saw (with regards to dia and width) -mounting of the slitting saw on the machine -clamping of the workpiece on the milling machine table -procedure to be followed	Indexing Calculations Worm Drive -basic definitions -calculating the pitch	Dimensioning -turning, milling and drilling processes	73

19.8	WT How to Cut Slots on a Milling Machine -slitting saw (shape, size and function) -selection of slitting saw (with regards to dia and width) -clamping of workpiece on the machine table -procedure to be followed	Worm Drive -calculating the lead and advance	Drawing from Models -puller	74

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
20	MANUFACTURE OF GEARS			
20.1	WT Gears and Use of Gears -use of gears -shape of gears and gearing -profile of teeth -dimensions of spur gears	Worm Drive -calculating the Rpm and speed ratio		
20.2	WT Gears and Manufacture of Gears -materials used for gears (metallic and plastic gears) -manufacture of gear blanks -manufacture of gears (cutting depth)	Worm Gearing for Indexing -basic design and names of parts -formula for calculating the no. of turns of the crank	Drawing from Models -clamping device	75
20.3	WT Manufacture of Spur Gears -manufacture of spur gears with indexing method -discussion on selection of teeth and operation plan for milling of spur gears by indexing method	Rapid Indexing -calculating the no. of holes to move		
20.4	WT Manufacture of Spur Gears -cutting of spur gears by hobbing -gear shaping- shaping of spur gear teeth, shaping of teeth with indexing, shaping of teeth with the generating method	Simple Indexing -calculating the no. of turns of index crank		

20.5	WT Manufacture of Gears -grinding the teeth flanks of spur gears -manufacture of worms and worm wheels -manufacture of bevel gears -measuring and testing of profiles of gears	Indexing Calculations -practice of solving the problems	Reading of Drawings I -dove-tail guide	76 76.1

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
21	SLOTTING AND SLOTTING MACHINE			
21.1	WT Slotting Operation and Slotting Machine -slotting operation (purpose) -design and function of slotting machine -main drive and main feed of the slotting machine -slotting tools (shape and material)	Change Gear Calculations Simple Gearing -calculating the transmission ratio and suitable gears	Reading of Drawings I	
21.1	WT Slotting of Keyways -slotting of a keyway or internal groove on slotting machine (discussion on operation plan) -manufacturing process -measuring and testing of keyways	Compound Gearing -calculating the transmission ratio and suitable sets of gears		

Unit No.	TECHNOLOGY	TECHNICAL MATHEMATICS	TECHNICAL DRAWING	Sheet No.
22	BROACHING AND BROACHING MACHINES			
22.1	WT Broaching and Broaching Tools -internal and external broaching -broaching process -broaching tools (shape, working directions for broaching tools)	Thread Cutting Calculations -calculations when cutting inch threads with inch lead screw -calculations when cutting inch threads with metric lead screw		
22.2	WT Broaching Machines -broaching machine (design, functions of main parts) -broaching of spline bores on broaching machine (discussion on the operation plan)	Thread Cutting Calculations -calculations when cutting metric threads with inch lead screw	Review	
22.3	Review	Review	Review	

PROJECTS FOR THEORETICAL INSTRUCTIONS

FOR TURNER AND MACHINIST

1. Clamping Prism
2. Screw Jack
3. Eccentric Drive
4. Fixture for Round Bars
5. Sliding Gear Drive
6. Spur Gear
7. Vee-Pulley
8. Soline Shaft
9. Claw Clutch

Parts of 'Sliding Gear Drive'

10. Double Start Worm Shaft
11. Tool Post
12. Tailstock

S P U R G E A R (Sliding Gear Drive)

1. Purpose of Spur Gear

1.1 General purpose
1.2 Special purpose of sliding gears

2. Representation, Design, Application

2.1 Simplified and symbolic representation of the spur gear
2.2 ISO-symbols of fits
2.3 Module
2.4 Design of the block of sliding gears
2.5 Design of the block of fixed gears
2.6 Hardness symbol; recognition

3. Materials and Tools

3.1 Materials for gear production
3.2 Comparison: welded gear - cast gear
3.3 Machine tools for spur gear production
3.4 Machine tools for indexing method
3.5 Choice of the appropriate cutter
3.6 Machine tools for slotting the gear
3.7 Choice of the lathe tools
3.8 Materials of turning tools
3.9 Roughing and finishing tools
3.10 Clamping devices for turning tools

4. Manufacturing Problems

4.1 'Forming' and 'Generating' of gears
4.2 Points of special attention when milling gears
4.3 Gear-hobbing
4.4 Hardening of gears
4.5 Grinding of gears

5. Sequences of Operations

5.1 Sequence of turning operations
5.2 Production of the key way
5.3 Sequence of milling operations

6. Measuring and Checking

6.1 Key way: checking the depth, width and alignment
6.2 Checking the function
6.3 Measuring the thickness of teeth, testing the alignment of teeth, concentricity, shape and pitch

7. Related Calculations

7.1 Tolerances and off-sizes
7.2 Pitch diameter
7.3 Distance of shafts; transmission ratio
7.4 Thickness of chips
7.5 Cutting speed, machining time
7.6 Spur gear: calculations on the dividing operation
7.7 Table drive of the milling machine: transmission ratios and number of revolutions
7.8 Calculation of module and cutting depth

HARDENABLE STEEL ▽▽ (▽, ▽▽)

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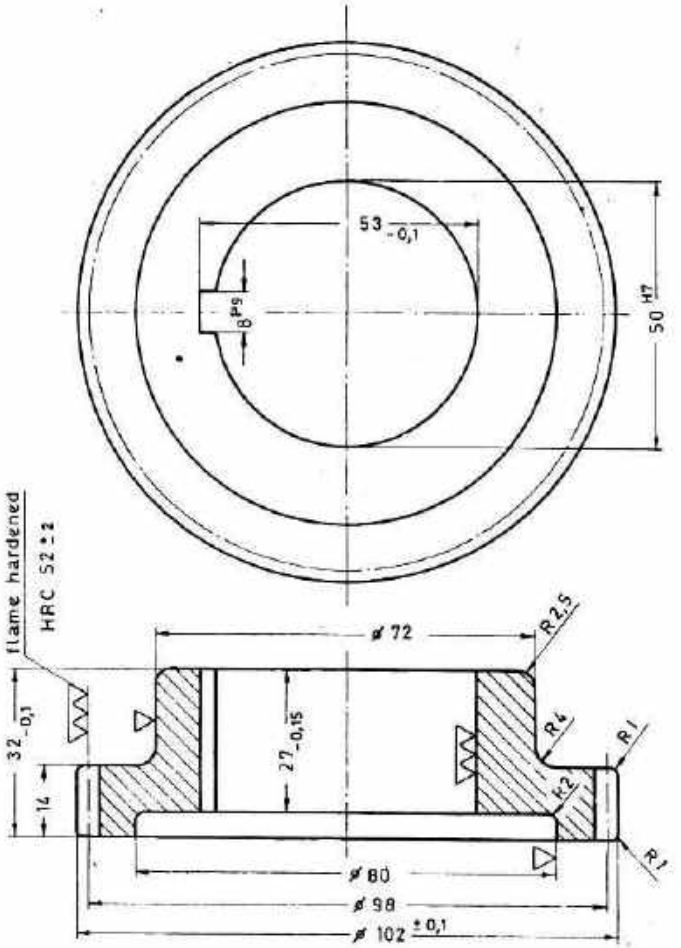
m = 2



SCALE 1:1	SPUR GEAR (Part 4 of Sliding Gear Drive)	
TRADE THEORY 3rd YEAR		Turner / Machinist
		PROJECT No. 6

DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING

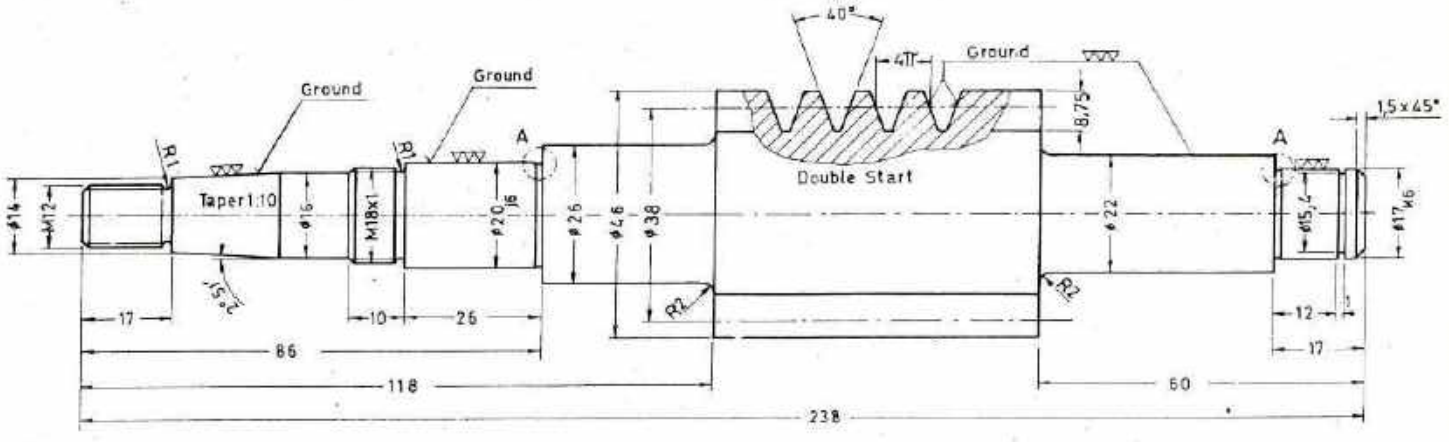
PAK-GERMAN TECHNICAL TRAINING PROGRAMME

6.1

Project No. 10 Turner/machinist

DOUBLE START WORM - SHAFT

1. Purpose of a Worm
   - 1.1 Technical needs to be suited by a worm gear drive: great reduction of speed; transmission of high forces; transmission of motion with intersecting shafts.
   - 1.2 Achieving different transmission ratios with worm gear drives: changing pitch; changing lead; changing number of teeth of the worm wheel.
   - 1.3 Acme thread applied as motion thread: forces at an inclined plane; selflocking effect of a worm; friction, efficiency.
   - 1.4 Purposes of different portions of the worm shaft.
2. Representation, Design, Application
   - 2.1 Dimensions and terms of a worm.
   - 2.2 Representation of worm and worm wheel with standard symbols.
   - 2.3 Difference between thread and worm when dimensioning pitch (P) and lead (L).
   - 2.4 Examples of application of worm gear drives.
3. Materials and Tools
   - 3.1 Standard symbols and properties of materials used for worms.
   - 3.2 Lathe tools for cutting worm threads; concave grinding, angles of the cutting edge.
   - 3.3 Milling and grinding worms.
4. Manufacturing Problems
   - 4.1 Production of a worm in one or two steps.
   - 4.2 Depth setting of the tool.
   - 4.3 Methods of producing a multi start worm.
5. Sequence of Operations
   - 5.1 Manufacturing the double start worm-shaft.
   - 5.2 Economical considerations for the production of a great number of pieces.
6. Measuring and Checking
   - 6.1 Different measuring tools
   - 6.2 Measuring outside dia, root dia and dimensions with given off-sizes.
   - 6.3 Checking the pitch and the profile of worm.
7. Related Calculations
   - 7.1 Module
   - 7.2 Change gears
   - 7.3 Number of teeth of worm wheels



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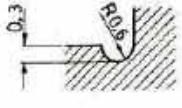
ø 17 k6	$\begin{smallmatrix}+12\\-1\end{smallmatrix}$

Detail A



SCALE 1:1	DOUBLE START WORM SHAFT	MAT. 41 Cr 4 V
TRADE THEORY 3rd YEAR		Turner / Machinist Project No. 10
DEVELOPMENT CELL FOR SKILLED LABOUR TRAINING PAK-GERMAN TECHNICAL TRAINING PROGRAMME		10.1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