6.1 PRODUCTION MANAGEMENT

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RATIONALE

Diploma holder is responsible for controlling production and quality of the product on the shop floor as well as for production planning and control. He is also required to supervise erection, installation and maintenance of equipment including material handling and undertake work-study for better utilization of resources. For this purpose, knowledge and skills about these topics need to be imparted to them. This subject aims at development of competencies to prepare material, equipment schedule and production control schedules and maintain required quality levels. In addition, it will also help in developing skills in erection, installation and testing of equipment.

Learning Outcomes

After undergoing this course, the students will be able to:

- Solve planning, scheduling and sequencing problems for shop floor
- Interpret different kinds of production systems
- Prepare break-even analysis and Gantt chart.
- Locate suitable plant location and draw plant layout for different production system.
- Handle different type of material and tools safely and effectively.
- Apply work study techniques for improving production
- Maintain inventory optimally and classify different types of inventory
- Use industrial engineering concepts to improve productivity
- Use resources optimally and economically.
- Carryout estimating and costing of production cost
- Apply different techniques to improve quality of products and processes.

DETAILED CONTENTS.

1. Production Planning and Control (PPC) (05 hrs)

    1.1 Introduction.
    1.2. Objectives and factors affecting PPC
    1.3. Functions(Elements) of PPC - Planning, Routing, Loading, scheduling, dispatching, progressing and inspection
    1.4. Types of production system - Flow or continuous production, Intermittent Production
    1.5. Production Control - Objectives and fields of production control, Production control system
    1.6 Break even analysis and Gantt chart.

2. Plant Location, Layout and Material Handling (09 hrs)

2.1 Definition and Factors affecting the plant location, Rural versus Urban Plant sites.
2.2 Definition and importance of Plant layout, Factors affecting plant layout.
2.3 Types of Plant layout- Process, product, combination and fixed position layout..
2.4 Methods of plant layout - Process flow charts, layout analogues Travel chart, distance, volume matrix.,
2.5. Plant layout procedure and work station design.
2.6. Material Handling- Definition, Significance and objectives of material handling, Principles of economic material handling,. Types of material handling equipment - Characteristics and classification of material handling equipment, Hoisting and conveying equipment (different types), Safety requirements while using material handling equipment

3. Work Study (10 hrs)

3.1 Production System and Productivity(Introduction and definitions), Difference between Production and productivity, Measures to improve productivity
3.2 Definition, advantages and procedure of work study

3.3 Method study – Definition, Objectives and Procedures, Process chart symbols, outline process chart, Flow process charts, Two handed processes charts, Multiple activity chart(Man-Machine charts), Flow diagram, string diagram.

3.4 Principles of motion economy, Therblig symbols, SIMO chart.

3.5. Work Measurement :- Definition and objective, Work measurement technique, Time Study- Definition, objectives and procedure, Calculation of basic time, performance rating and its techniques, normal time, allowance and its types, standard time (simple numerical problems)

4. Inventory Control (8 hrs)

4.1 Definition and objectives of inventory control.
4.2 Inventory types
4.3 Procurement and carrying cost, EOQ, lead time, reorder point (simple numerical problems)
4.4 Inventory Classification - ABC Analysis, VED Analysis, FMS Analysis

4.5 Standardization and Codification - Objective and advantages of standardization, Levels and types of standards, .Objective and advantages of codes. Coding systems-. National and International Codes

4.6. Concept of Just-In-Time (JIT)

5. Inspection and Quality Control (08 hrs)

5.1. Inspection – Introduction, Need and Importance
5.1.1. Types of Inspection
5.1.2. Role of operator and inspector in inspection

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5.2 Quality Control
5.2.1 Introduction, Need and Importance
5.2.2 Factors affecting product quality

5.3 Quality Assurance

5.4 Statistical Quality Control (SQC)
5.4.1 Acceptance Sampling, Sampling Plan- Single and double sampling plan
5.4.2 Operating Characteristics Curve
5.4.3 Control Charts – Introduction, advantages, Types of control charts (X, R, p and c charts)

6. Repair and Maintenance (06 hrs)

6.1 Objectives and importance of Maintenance
6.2 Different types of maintenance- Corrective or Breakdown maintenance, Scheduled Maintenance, Preventive Maintenance, Predictive Maintenance
6.3 Nature of maintenance problems
6.4 Range of maintenance problems

7. Value Engineering (04 hrs)

7.1 Introduction, Concept
7.2 Objectives of value engineering
7.3 Value Analysis Procedures
7.4 Benefits of value analysis
7.5 Technique of value engineering

8. Cost Estimation and Control: (14 hrs)

8.1 Definition and functions of cost estimation
8.2 Estimation procedure
8.3 Elements of cost, ladder of costs (simple numericals)
8.4 Overhead expenses and its distribution
8.5 Depreciation - Concept and Definition, Methods of calculating depreciation- Straight line method, Diminishing Balance Method, Sinking fund method (Numerical problems).
8.6 Cost control- definition and objectives, Capital cost control (planning and scheduling), operating cost control.

8.7 Cost estimation for machining processes like turning, drilling, and milling. Cost estimation of forming processes like forging, pattern making, and casting .

INSTRUCTIONAL STRATEGY

1. Teacher should put emphasis on giving practical problems related to plant location and plant layout
2 Students should be taken to industrial units to give an exposure of production environment, plant layout and material handling
3 Live problems may be given to students to carry out case studies in teams under guidance of teacher

RECOMMENDED BOOKS

1. Industrial Engineering and Management by T.R. Banga and SC Sharma; Khanna Publishers, Delhi.
2. Industrial Engineering and Management by O.P. Khanna; Dhanpat Rai and Sons, New Delhi.
3. Production Management by C.L. Mahajan; Satya Parkashan Company Limited, New Delhi.
4. Mechanical Costing, Estimation and Project Planning by CK Singh; Standard Publishers, New Delhi.
5. A Text Book of Reliability and Maintenance Engineering by A Manna, Prentice Hall of India

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	5	10
2	9	15
3	10	15
4	8	12
5	8	12
6	6	10
7	4	6
8	14	20
Total	**64**	**100**

6.2 MACHINE DESIGN

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RATIONALE

A diploma holder in this course is required to assist in the Design and Development of Prototype and other components. For this, it is essential that he is made conversant with the principles related to design of components and machine and application of these principles for designing. The aim of the subject is to develop knowledge and skills about various aspects related to design of machine components.

LEARNING OUTCOME

At the end of this course, students will be able to:

- Explain the terms related to design.
- Use codes and standards for designing a component.
- Select material for designing a component.
- Interpret the various causes of design failures.
- Design shaft on the basis of strength and rigidity.
- Design various machine elements (key, joint, flange coupling and screwed joints)

DETAILED CONTENTS

1. Introduction (08 hrs)

1.1 Design – Definition, Type of design, necessity of design

1.1.1 Comparison of designed and undesigned work
1.1.2 Design procedure
1.1.3 Characteristics of a good designer

1.2 Design terminology: stress, strain, factor of safety, factors affecting factor of safety, stress concentration, methods to reduce stress concentration, fatigue, endurance limit.

1.2.1 General design consideration
1.2.2. Codes and Standards (BIS standards)

1.3 Engineering materials and their mechanical properties :

1.3.1 Properties of engineering materials: elasticity, plasticity, malleability, ductility, toughness, hardness and resilience. Fatigue, creep, tenacity, strength
1.3.2 Selection of materials, criterion of material selection

2. Design Failure (04 hrs)

2.1 Various design failures-maximum stress theory, maximum strain theory
2.2 Classification of loads
2.3 Design under tensile, compressive and torsional loads.

3. Design of Shaft (10 hrs)

3.1 Type of shaft, shaft materials, Type of loading on shaft, standard sizes of shaft available
3.2 Shaft subjected to torsion only, determination of shaft diameter (hollow and solid shaft) on the basis of :
- Strength criterion
- Rigidity criterion
3.3 Determination of shaft diameter (hollow and solid shaft) subjected to bending
3.4 Determination of shaft diameter (hollow and solid shaft) subjected to combined torsion and bending .

4. Design of Key (06 hrs)

4.1 Types of key, materials of key, functions of key
4.2 Failure of key (by Shearing and Crushing).
4.3 Design of key (Determination of key dimension)
4.4 Effect of keyway on shaft strength. (Figures and problems).

5. Design of Joints (20 hrs)

Types of joints - Temporary and permanent joints, utility of various joints

5.1 Temporary Joint:

5.1.1 Knuckle Joints – Different parts of the joint, material used for the joint, type of knuckle Joint, design of the knuckle joint. (Figures and problems).
5.1.2 Cotter Joint – Different parts of the spigot and socket joints, Design of spigot and socket joint.

5.2 Permanent Joint:

5.2.1 Welded Joint - Welding symbols. Type of welded joint, strength of parallel and transverse fillet welds.
5.2.2 Strength of combined parallel and transverse weld.
5.2.3 Riveted Joints. : Rivet materials, Rivet heads, leak proofing of riveted joint – caulking and fullering.
5.2.4 Different modes of rivet joint failure.
5.2.5 Design of riveted joint – Lap and butt, single and multi riveted joint.

6. Design of Flange Coupling (08 hrs)

Necessity of a coupling, advantages of a coupling, types of couplings, design of muff coupling, design of flange coupling. (both protected type and unprotected type).

7. Design of Screwed Joints (08 hrs)

7.1 Introduction, Advantages and Disadvantages of screw joints, location of screw joints.
7.2 Important terms used in screw threads, designation of screw threads
7.3 Initial stresses due to screw up forces, stresses due to combined forces
7.4 Design of power screws (Press, screw jack, screw clamp)

Note : a) Use of design data book during the examination is allowed.

b) The paper setter should provide all the relevant data for the machine design numericals in the question paper.

INSTRUCTIONAL STRATEGY

1. Use moulds of various parts/components.
2. Presentation should be arranged for various topics.

RECOMMENDED BOOKS

1. Machine Design by R.S. Khurmi and JK Gupta, Eurasia Publishing House (Pvt.) Limited, New Delhi.
2. Machine Design by V.B.Bhandari, Tata McGraw Hill, New Delhi.
3. Engineering Design by George Dieter; Tata McGraw Hill Publishers, New Delhi.
4. Mechanical Engineering Design by Joseph Edward Shigley; McGraw Hill, Delhi.
5. Machine Design by Sharma and Agrawal; Katson Publishing House, Ludhiana.
6. Design Data Handbook by D.P. Mandali, SK Kataria and Sons, Delhi.
7. Machine Design by A.P.Verma; SK Kataria and Sons, Delhi
8. Machine Design by AR Gupta and BK Gupta ; Satya Parkashan, New Delhi.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	08	12
2	04	06
3	10	16
4	06	10
5	20	32
6	08	12
7	08	12
Total	**64**	**100**

6.3 AUTOMOBILE ENGINEERING

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RATIONALE

These days, automobile has become a necessity instead of luxury. The diploma holders in this course are required to supervise production and repair and maintenance of vehicles. For this purpose, knowledge and skills are required to be imparted to them regarding automobile industry as a whole. This subject aims at developing required knowledge and skills in this area.

LEARNING OUTCOMES

After undergoing this course, the students will be able to :

- identify and explain the function of different chassis components and drive types.
- maintain transmission system.
- carry out balancing of wheels to maintain steering geometry.
- carry out routine servicing of brake system and bleeding of hydraulic brakes
- carry out testing and charging of Lead-acid battery.
- interpret Bharat norms of exhaust emissions.

DETAILED CONTENTS

1. Introduction (06 hrs)

    1.1 Automobile and its development
    1.2 Various types of automobiles manufactured in India, their manufacturer and location of their manufacturing unit.
    1.3 Classification of automobiles
    1.4 Layout of chassis
    1.5 Types of drives-front wheel, rear wheel, four wheel.
    1.6 Introduction to electric and hybrid vehicles.
    1.7 Governing of fuel- carburettor, electronic control module (ECM i.e, 8 bit, 16 bit and 32 bit computers)
    1.8 Concept of double overhead cam, single overhead cam, Twin cam 16 valve technology in 4 cylinder engine.

2. Transmission System (12 hrs)

    2.1 Clutch - Function, Constructional details of single plate and multi plate friction clutches, Centrifugal and semi centrifugal clutch, Cone clutch, Hydraulic clutch

2.2 Gear Box - Function, Working of sliding mesh, constant mesh and synchromesh gear box, Torque converter and overdrive, Introduction to Automated Manual Transmission, Automatic transmission and Continuously Variable Transmission.

2.3 Propeller shaft and rear axle - Function, Universal joint, Differential, Different types of rear axles and rear axle drives.

2.4 Wheels and Tyres - Types of wheels, Types and specifications of tyres used in Indian vehicles, Toe in, toe out, camber, caster, kingpin inclination, Wheel balancing and alignment, Factors affecting tyre life.

3. Steering System (06 hrs)

Function and principle, Ackerman and Davis steering gears, Types of steering gears - worm and wheel, rack and pinion, Power steering-Hydraulic and Electrical.

4. Braking system (08 hrs)

Constructional details and working of mechanical, hydraulic, air and vacuum brake, Relative merits and demerits. Details of master cylinder, wheel cylinder, Concept of brake drum, brake lining/pad and Brake adjustment, Introduction to Anti-lock Brake System and its working.

5. Suspension System (08 hrs)

Function and types of Coil spring, leaf spring, Air suspension, Shock absorber –Function, construction and working of Telescopic type.

6. Battery (10 hrs)

Constructional details of lead acid cell battery, Specific gravity of electrolyte - effect of temperature on specific gravity, Specification of battery-capacity, rating , number of plates, selection of battery for particular use, Battery charging, chemical reactions during charge and discharge, Maintenance of batteries, Checking of batteries for voltage and specific gravity. Batteries for electric and hybrid vehicles.

7. Dynamo and Alternator (10 hrs)

7.1 Dynamo - Function and details, Regulators - voltage current and compensated type, Cutout - construction, working and their adjustment,

7.2 Alternator - Construction and working, Charging of battery by alternator. Introduction to Integrated starter-alternator.

8. Exhaust Emissions (04 hrs)

Types and use of catalytic converters, selective catalytic reduction methods for emission control, emission norm standards i.e. Bharat norms.

LIST OF PRACTICALS

1 Fault and their remedies in Battery Ignition system

2 Adjustment of Head Light Beam (ii) Wiper and Indicators.

3 Dismantling and inspection of (i) AC Pump (ii) SU Pump

4 Dismantle (i) rear axle (ii) differential and find out the gear ratio of crown wheel & driven sun gear and planet pinion..

5 Fault finding practices on an automobile - four wheelers (petrol/ diesel vehicles).

6. Servicing/Tuning of a 2 wheeler/4 wheeler.

7. Servicing of hydraulic brakes :
   a) adjustment of brakes
   b) bleeding of brakes
   c) fitting of leather pads

8 Tuning of an automobile engine.

9 Testing and Charging of an automobile battery and measuring cell voltage and specific gravity of electrolyte.

10 Changing of wheels and inflation of tyres, balancing of wheels.

11 Measuring spark gap, valve clearance and ring clearance; carrying out cleaning operations for adjustment.

INSTRUCTIONAL STRATEGY

1. Use computer based learning aids for effective teaching-learning
2. Expose the students to real life problems
3. Plan assignments so as to promote problem solving abilities and develop continued learning skills

RECOMMENDED BOOKS

1. Automobile Engineering by GBS Narang; Khanna Publishers, Delhi.
2. Automobile Engineering by Dr. Kirpal Singh; Standard Publishers and Distributors, Delhi.
3. Automotive Mechanics, by W.Crouse and Anglin; Tata McGraw Hill, Delhi.
4. Automobile Engineering by G. S. Aulakh; Eagle Prakashan, Jalandhar

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	6	10
2	12	20
3	6	10
4	8	12
5	8	12
6	10	16
7	10	14
8	04	06
Total	**64**	**100**

6.4 CNC MACHINES AND AUTOMATION

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RATIONALE

Diploma holders are required to supervise and handle specialized machines and equipment like CNC machines. For this purpose, knowledge and skills about NC machines, part programming in NC machines and tooling for CNC machines are required to be imparted for enabling them to perform above functions. This subject aims at development of knowledge and skills about CNC machines, tools, equipment and use of high tech machines for increased productivity and quality.

LEARNING OUTCOMES

After undergoing this course, the students will be able to :

- Explain the construction and tooling of CNC machine.
- Prepare simple part programme.
- Operate a CNC lathe.
- Operate a CNC milling machine.
- Diagnose common problems in CNC machines.
- Explain the trends in the field of automation.

DETAILED CONTENTS

1. Introduction (12 hrs)

   Introduction to NC, CNC & DNC, their advantages, disadvantages and applications, Machine Control Unit, input devices, serial communication and Ethernet techniques, selection of components to be machined on CNC machines, Problems with conventional NC, New developments in NC, Axis identification, PLC Control and its components.

2. Construction and Tooling (10 Hrs)

   Design features, specification Chart of CNC machines, use of slideways, balls, rollers and coatings, motor and leadscrew, swarf removal, safety and guarding devices, various cutting tools for CNC machines, overview of tool holder, different pallet systems and automatic tool changer system, management of a tool room.

3. Part Programming (16 Hrs)

   Part programming and basic concepts of part programming, NC words, part programming formats, simple programming for rational components, part programming using canned cycles, subroutines and do loops, tool off sets, cutter radius compensation and wear compensation.

4. System Devices (12 Hrs)

Actuators, Transducers and Sensors, Tachometer, LVDT, opto-interrupters, potentiometers for linear and angular position, encoder and decoder, axis drives, open loop system, close loop system.

5. Problems in CNC Machines (06 Hrs)

Common problems in mechanical, electrical, pneumatic, electronic and PC components of NC machines, diagnostic study of common problems and remedies, use of on-time fault finding diagnosis tools in CNC machines.

6. Automation and NC system (08 Hrs)

Role of computer in automation, emerging trends in automation, automatic assembly, manufacture of magnetic tape, manufacture of printed circuit boards, manufacture of integrated Circuits, Overview of FMS, Group technology, CAD/CAM and CIM.

LIST OF PRACTICALS

1 Study the constructional details of CNC lathe.

2. Study the constructional details of CNC milling machine.

3. Study the constructional details and working of:

- Automatic tool changer and tool setter
- Multiple pallets
- Swarf removal
- Safety devices

4. Develop a part programme for following lathe operations and make the job on CNC lathe and CNC turning center.

- Plain turning and facing operations
- Taper turning operations
- Operation along contour using circular interpolation.

5. Develop a part programme for the following milling operations and make the job on CNC milling

- Plain milling
- Slot milling
- Contouring
- Pocket milling

6. Preparation of work instruction for machine operator

7. Preparation of preventive maintenance schedule for CNC machine.

8. Demonstration through industrial visit for awareness of actual working of FMS in production.

9. Use of software for turning operations on CNC turning center.

10. Use of software for milling operations on machine centres.

INSTRUCTIONAL STRATEGY

This is highly practice-based course. Efforts should be made to develop programming skills amongst the students. During practice work, it should be ensured that students get opportunity to individually perform practical tasks.

RECOMMENDED BOOKS

1. CNC Machines – Programming and Applications by M Adithan and BS Pabla; New Age International (P) Ltd., Delhi.
2. Computer Aided Manufacturing by Rao, Kundra and Tiwari; Tata McGraw Hill, New Delhi.
3. CNC Machine by Bharaj; Satya Publications, New Delhi.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	20
2	10	16
3	16	26
4	12	18
5	06	10
6	08	10
Total	**64**	**100**

6.5 PROJECT WORK

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RATIONALE

Major Project Work aims at developing innovative skills in the students whereby they apply in totality the knowledge and skills gained through the course work in the solution of particular problem or by undertaking a project. In addition, the project work is intended to place students for project oriented practical training in actual work situation for the stipulated period.

LEARNING OUTCOMES

After undergoing the project work, students will be able to:

Apply in totality the knowledge and skills gained through the course work in the solution of particular problem or by undertaking a project. In addition, the project work is intended to place the learner for project oriented practical training in actual work situation for the stipulated period with a view to:

- Develop understanding regarding the size and scale of operations and nature of field-work in which students are going to play their role after completing the courses of study

- Develop understanding of subject based knowledge given in the classroom in the context of its application at work places.

- Develop first hand experience and confidence amongst the students to enable them to use and apply polytechnic/institute based knowledge and skills to solve practical problems related to the world of work.

- Develop abilities like interpersonal skills, communication skills, positive attitudes and values etc.

General Guidelines

The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work, they would like to execute. The activity of problem identification should begin well in advance (say at the end of second year). Students should be allotted a problem of interest to him/her as a major project work. It is also essential that the faculty of the respective department may have a brainstorming session to identify suitable project assignments for their students. The project assignment can be individual assignment or a group assignment. There should not be more than 3 students if the project work is given to a group. The project work identified in collaboration with industry should be preferred.

This practical training cum project work **should not be considered** as merely conventional industrial training in which students are sent at work places with either minimal or no supervision. This experience is required to be planned in advance and supervised on regular basis by the polytechnic faculty. For the fulfillment of above objectives, polytechnics may establish close linkage with 8-10 relevant organization for providing such an experience to students. It is necessary that each organization is visited well in advance and activities to be performed by students are well defined. The chosen activities should be such that it matches with the curricular interest to students and of professional value to industrial/ field organizations. Each teacher is expected to supervise and guide 5-6 students.

The projects given to students should be such for which some one is waiting for solution. Some of the suggested project activities are given below:

1. Projects connected with repair and maintenance of machines.
2. Estimating and costing projects.
3. Design of jigs / fixtures.
4. Projects related to quality control.
5. Project work related to increasing productivity.
6. Projects relating to installation, calibration and testing of machines.
7. Projects related to wastage reduction.
8. Project, related to fabrication.
9. Energy efficiency related projects.
10. Projects related to improving an existing system

NOTE: Each student has to take one project individually and one to be shared with a group of four-five students depending upon cost and time involved. There is no binding to take up the above projects as it is only a suggestive list of projects.

A suggestive criterion for assessing student performance by the external (person from industry) and internal (teacher) examiner is given in table below:

Sr. No.	**Performance Criteria**	**Max.** Marks**	**Rating Scale**				
			Excellent	**Very Good**	**Good**	**Fair**	**Poor**
1.	Selection of project assignment	10%	10	8	6	4	2
2.	Planning and execution of considerations	10%	10	8	6	4	2
3.	Quality of performance	20%	20	16	12	8	4
4.	Providing solution of the problems or production of final product	20%	20	16	12	8	4
5.	Sense of responsibility	10%	10	8	6	4	2
6.	Self expression/ communication skills	5%	5	4	3	2	1
7.	Interpersonal skills/human relations	5%	5	4	3	2	1
8.	Report writing skills	10%	10	8	6	4	2
9	Viva voce	10%	10	8	6	4	2
	Total marks	**100**	**100**	**80**	**60**	**40**	**20**

The overall grading of the practical training shall be made as per following table.

In order to qualify for the diploma, students must get "Overall Good grade" failing which the students may be given one more chance to improve and re-evaluate before being disqualified and declared "not eligible to receive diploma ". It is also important to note that the students must get more than six "goods" or above "good" grade in different performance criteria items in order to get "Overall Good" grade.

	Range of maximum marks	**Overall grade**
i)	More than 80	**Excellent**
ii)	79 < > 65	Very good
iii)	64 < > 50	Good
iv)	49 < > 40	Fair
v)	Less than 40	Poor

Important Notes

1. **This criteria must be followed by the internal and external examiner and they should see the daily, weekly and monthly reports while awarding marks as per the above criteria.**

2. **The criteria for evaluation of the students have been worked out for 200 maximum marks. The internal and external examiners will evaluate students separately and give marks as per the study and evaluation scheme of examination.**

3. **The external examiner, preferably, a person from industry/organization, who has been associated with the project-oriented professional training of the students, should evaluate the students performance as per the above criteria.**

4. **It is also proposed that two students or two projects which are rated best be given merit certificate at the time of annual day of the institute. It would be better if specific nearby industries are approached for instituting such awards.**

The teachers are free to evolve other criteria of assessment, depending upon the type of project work.

It is proposed that the institute may organize an annual exhibition of the project work