University although the equipment is obsolete and can provide its students with basic education necessary for mining engineers.

Table 3-13 shows a model for themes of experiments and necessary equipment for a mining engineering department. For Dharma Agung University it would be appropriate to provide equipment necessary for observation of minerals since it has nearly nothing. For University of Sriwijaya, oil analysis related equipment will be provided as discussed above.

3.2.5 Relation to the HEDS

This grant aid cooperation project was requested by the Indonesian government in the process of the HEDS project. The HEDS project is already in progress in the form of a project type technical cooperation scheme and R/D was signed between the Japanese side and the Indonesian side on April 12, 1990. As shown in Table 2-4 and Fig. 3-1, the above mentioned technical cooperation scheme is closely linked with this grant aid cooperation project and directs this. The relations of both projects are as follows:

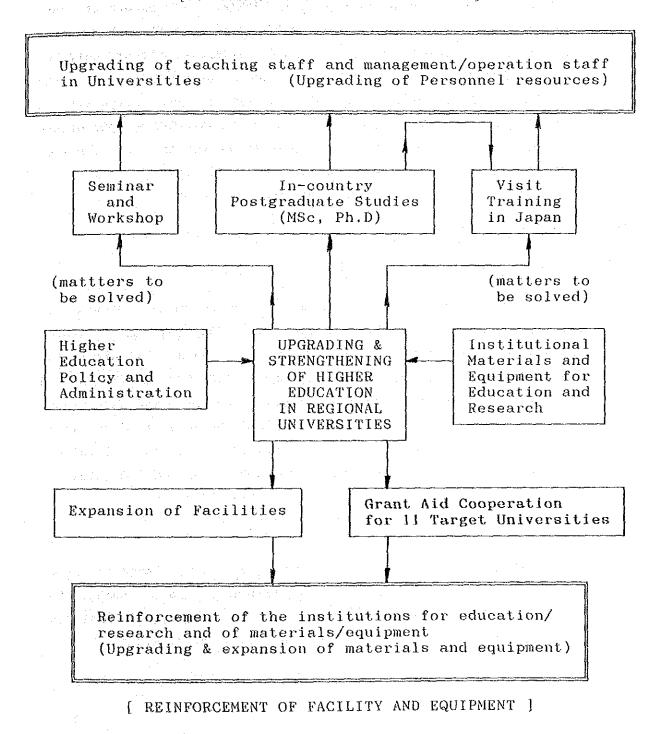
- (1) The technical cooperation project trains young teaching staff of the engineering departments of the 11 target universities in three allotment in five years. Those who obtained higher degrees through this training and teaching staff who attended seminars and workshops on recent topics in science and technology and on recent engineering education methods are expected to utilize equipment provided by the grant aid project for experiments and practices of S-1 grade students of the engineering departments of the 11 target universities. The above mentioned workshops and seminars are also activities of the technical cooperation project.
- (2) The technical cooperation project provides the host training institution which performs training mentioned above with equipment which is to be used by the trainees for their research. In the circumstances, these young teaching staff are expected to acquire skills of experimental technique and equipment maintenance. Thus the maintenance system of equipment for S-1 grade student experi-

ments provided through the grant aid project will be improved and effective and ingenious use of the equipment is expected on their own initiatives.

(3) Provision of eduational and training equipment by this grant aid will activate student experiments and increase opportunities of the participation of more teachers in ORT (On the Research Training) concerning university management such as budget control, facility maintenance, administration of practice courses. and the second secon

Figure 3-1 CONCEPT DIAGRAM OF THE PROJECT

[DEVELOPMENT OF HUMAN RESOURCES]



3.2.6 Basic Policy for Implementation of Grant Aid Cooperation

The present evaluation confirms the benefits, feasibility and the project implementation capacity of Indonesia. It is judged appropriate to implement this project within the framework of grant aid of the Japanese government since the purpose and expected results are in line with the grant aid rationale. Accordingly, on the assumption of a grant aid of the Japanese government, the outline of the Project will be reviewed and a Basic Design will be prepared as in the following. However, it is considered appropriate to modify part of the request, as mentioned in the evaluation of requested facilities and equipment.

3.3 Outline of the Project

3.3.1 Executing Body and Operation System

The executing Body of this project is the Directorate General of Higher Education (DGHE), Ministry of Education and Culture, Indonesia. As shown in Diagram A-13-2 in Appendix 13, within the DGHE, Bureau of Academic Affairs, Bureau of Student Affairs and Bureau of Research and Community Services are in charge directly of the national universities, while Bureau of Private Institutions is in charge of private universities on a central government level and in the regions Private Education Secretariat on a regional level.

3.3.2 Plan of Activities

The Project is to expand educational equipment necessary for practice courses for S-1 grade level (equivalent to undergraduate) students of the engineering departments of the following eleven target universities:

Target Universities:

In Sumatera

• ,	
	University of Syiah Kuala (Banda Aceh, national)
	University of North Sumatera (Medan, national)
	University of Nommensen (Medan, private)
•	Dharma Agung University (Medan, private)
	University of Medan Area (Medan, private)
	Islamic University of North Sumatera (Medan, private)
7	University of Andalas (Padang, national)
Ì.	University of Sriwijaya (Palembang, national)
	University of Lampung (Lampung, national)

In Kalimantan

University of Tanjungpura (Pontianak, national) University of Lambung Mangkurat (Banjarmasin, national)

Target Departments:

Civil Engineering (partly including Architectural Engineering) Mechanical Engineering

Electrical Engineering (includes Electronic Engineering) Chemical Engineering

Industrial Management (equivalent to Industrial Engineering) Mining Engineering

University Administration

3.3.3 Proposed Project Sites

1.1

Proposed project sites are in Seven cities in Sumatera and Kalimantan. The Location of each University is shown in Appendix 5.

3.3.4 Outline of Equipment Requested

Equipment was selected for S-1 grade student experiments in following departments as a result of detailed study of the existing equipment and expansion plans of each department.

a. Laboratory equipment for civil engineering department

- b. Laboratory equipment for mechanical engineering department
- c. Laboratory equipment for electrical engineering department
- d. Laboratory equipment for chemical engineering department
- e. Laboratory equipment for industrial engineering department
- f. Laboratory equipment for mining engineering department
- g. Equipment for university management

Followings are list of major practice themes and equipment.

(1) Laboratory Equipment for Civil Engineering Department

There are ll target universities which have a civil engineering department. The following equipment will be selected for them.

- Surveying Practice Equipment (Transit, Tripod, Theodolite, Plate, Level etc.)
- Soil Test Equipment (Trimmer, Pycnometer, Liquid Limit Appratus, Practice Size Measuring Apparatus, etc.)
- Concrete Testing Equipment (Balance, Mixer, Compressive Strength Test, Dryer, etc.)
- Pavement Testing Equipment (Penetration Test Equipment, Softening Point Tester Set, Flash Point Tester, etc.)
- Hydraulics Experiment Equipment (Ventury Meter, Wave Generation Tank, Open Channel Apparatus, Orifice Experiment Unit, etc.)
- (2) Laboratory Equipment for Mechanical Engineering Department

There are 8 target universities which have a mechanical engineering department. The following equipment will be selected for them.

- Workshop Practice Equipment (Lathe, Milling Machine, Drilling Machine, etc.)

- Material Testing Experimental Equipment (Universal Testing Machine, Universal Tensile Machine, Brinnell Hardness Tester, Chalpy Impact Testing Machine, etc.)
 - Heat Treatment and Casting Practice Equipment (Electric Furnace, Sand Mill, Shell Mould etc.)

- Welding Practice Equipment (Spot Welding Machine, Arc Welding Machine, etc.)

- Fluid Machinery Experimental Equipment (Piping System, Pressureloss Measuring Unit, Turbine Pump, Oriffice, etc.)
- Internal Combustion Engine Experimental Equipment (Gasoline, Engine, Specific Gravity Meter, Bomb calory meter, etc.)
- Refrigeration and Heat Transfer Experimental Equipment (Refrigerator, Calory Meter, etc.)
- Instrument/Machine Mechanics Experimental Equipment (Vibration Meter, Torquemeter, Oscilloscope, etc.)

- Common Miscellaneous Tool (Spaner, Piperench, Hammer, etc.)

(3) Laboratory Equipment for Electrical Engineering

There are 7 target universities which have an electrical engineering department. The following equipment will be selected for them.

- Electromagnetic Basic Experimental Equipment (AC/DC Voltmeter, Ammeter, Variable Transformer, etc.)
- Electrical Machine Experimental Equipment (Wattmeter, Experimental Induction Motor, Torque Meter, etc.)
- High Voltage Experimental Equipment (Silicon Rectifier, High Voltage Test Set, Impulse Voltage Generators, etc.)

- Tele-communication and Electronics Equipment (Pulse Generator, X-Y Recorder, Microprocessor and Computer Testing Unit, etc.)

- Common Electrical Tool (Drill, Tester, Spanner, Pliers, etc.)

(4) Laboratory Equipment for Chemical Engineering Department

There are 3 target universities which have a chemical engineering department, following equipment will be selected for them.

- Chemical Analysis Experimental Equipment (PH Meter, Platinum Crucible, Electrical Furnace, Refractometer, etc.)
- Physical Properties Measurement Equipment (Pycnometer, Ostwald-Viscosity Meter, Drying Oven, etc.)
- Fluid Experimental Equipment (Orifice Flow Meter, Centrifugal Pump, Packed Column, etc.)
- Heat Conductance Experiment Equipment (Stirrer, High and Low Temperature Tank, Millivolt Meter, etc.)
- Distillation Experiment Equipment (Microflask, Mantle Heater, Packed Column, etc.)
- Drying Experiment Equipment (Drying Chamber with Balance, Blower, etc.)
- Adsorption Experiment Equipment (Beaker, Stirrer, Fluorescence Adsorption Spectrophotometer, etc.)
- Filtration Testing Equipment (Leaf Filter, Vacuum Pump, etc.)
- (5) Laboratory Equipment for Industrial Engineering Department

There are 4 target Universities which have an industrial engineering department. The following equipment will be selected for them.

- Operational and Production Management and Statistics Practice Equipment (Video, Screen, Slide Projector, etc.)
- Production Design Practice Equipment (Drafter, Light, Table, etc.)
- Factory Planning Practice Equipment (Layout model, Machine Model, Template, etc.)
- Work Engineering Practice Equipment (Microchronometer, Stopwatch, etc.)
- Production/Human Engineering Practice Equipment (Video, Tape Recorder, Stopwatch, etc.)
- (6) Laboratory Equipment for Mining Engineering Department
 - There are 2 target Universities which have a mining engineering department. The followings equipment will be selected for them.
 - Rocks, Mineral Observation/Analysis Equipment (Rock Cutter, Small Sized Grinding Machine set, Microscope etc.)
 - Petroleum Analysis Equipment (Viscosimeter, Aniline Point Tester, Asphalt Penetration Tester, etc.)

- Prospecting Equipment (Resistivity Surveying Equipment, etc.)

3.3.5 Plan of Implementation and Operation

(1) Maintenance System

영금도로 이 같은 것을 가지 않는다.

Maintenance of equipment after the implementation of the Project is in charge of the staff members of the existing departments since the target departments are existing ones which have the current curricula and practice courses. In addition to teaching staff, there are a head and 4 or 5 assistants for experiments in each laboratory. So the equipment will be maintained following the present system without increasing the number of the staff.

The ratio of the teaching staff to students in the target universities is between 1-10 and 1-20. Since the criteria for equipment selection is for basic experiments for S-1 grade students, there will be no need to increase the number of staff for conducting additional experiments made possible by the new equipment. As the higher education development program mentioned before and other expansion plans of teachers are expected to increase the number of teaching staff by more than 60% in the Repelita V, there will be no problem with the shortage of teachers.

(2) Maintenance Costs

The maintenance costs to be borne by the universities including purchase costs for spare parts and costs for electricity, water etc. will increase after the implementation of this project. However, as often mentioned, equipment provided by this project is for S-1 grade student experiments and not expensive instruments with complicated electronic circuits or precision instruments, therefore the maintenance cost increase will be negligible. It is also noted that student experiments do not use equipment which consume a large amount of electricity, water, heat etc. Although actual figures will be examined in Chapter 4, Basic Design, the following is assumed an increase for one student per year.

Laboratory equipment	for civil engineering	:	Rp.1,000 - 3,000
Laboratory equipment	for mechanical engineering	:	Rp.2,000 - 5,000
Laboratory equipment	for electrical engineering	:	Rp.1,500 - 3,500
Laboratory equipment	for chemical engineering	:	Rp.1,000 - 2,000
Laboratory equipment	for industrial engineering	:	Rp.200 - 500
Laboratory equipment	for mining engineering	:	Rp.500 - 1,000

The reason why any given department shows a range of figures is that the amount of equipment held at present and to be provided by other bilateral and multilateral assistance programs differs from university to university. Since the tuition fees which a student of national university pays a year is about 100,000 Rupiah, the increase is at most by 5% of the present costs. If we consider the expenses some students must pay for ITB for their training in the practice courses which they can not take in their own university due to lack of proper equipment amount to 1 to 1.5 million Rupiah, the financial benefits as a whole will surpass the small increase of a student financial burden. The above is an outline of the Project based on the request of the DGHE and further clarified during the on site survey. The following sections will deal with a basic design of the Project.

Category	Category	Purpose of Training and Description	Major Equipment Used
Surveying	Distance measurement	To measure a distance on a flat land by using a steel tape, with the required accuracy of around 1/1000.	Steel tape, linen tape, poles, marking board (or marking stake), hammer, spring balance, grip handle, and thermometer
	Precision Distance Measurement	To measure a distance at a high degree of accuracy, such as a base line for triangulation.	Steel tape for base line measurement, transit, poles, staff, linen tape, piles (intermediate and bearing piles), tin-plate sheets, spacing balance grip handle, level, thermometer, nails (lage and small), maul, and hammer
	Angular Measurement	To get acquainted with the proper setting up of the transit (or theodolite) and the method of measurement	Transit (or theodolite), tripod, marking stakes, maul, nails, hammer, field book, and pencil or pen
	Traverse Survey	To get acquainted with the outline of traverse survey by determining a point from measured distances and horizontal angles.	Transit (or theodolite), steel tape, poles, marking pins, thermometer, piles, maul. felt pen, nails, hammer, field book, and pencil or pen
	Offset Survey	To get acquainted with the method of measuring a perpendicular distance from a reverence line to an object, which is needed to describe a location and size of the object on a topographic man	
	Plane Table Survey	To get acquainted with the proper setting up of the plane table over a point and the use of related devices.	Drawing board, tripod, alidade, center marker, compass box, marking pins, poles, field book, and pencil or pen
	Leveling	To get acquainted with the proper setting up, adjustment, and use of the level, and to measure a level to a point.	
	Studio Survey	To determine a distance or level from a point by reading a staff set at the point through studio hairs on a telescope of a transit or alidade.	Transit, staff, line tape, field book, and pencil or pen
	Triangulation	To get acquainted with overall triangulation work Those used in by applying basic surveying techniques including measurement distance measurement and angular measurement.	d Those used in distance measurement and angular measurement
	Photo Survey		Mirror stereoscope, aerial photographs, scale and ruler, marking pins, parallax wege

Table 3-3 (1) Details of Model Civil Engineering Laboratory Activities

	Table	3-3 (2) Details of Model Civil Engineering Laboratory Activities	
· · ·			
	Category	Purpose of Training and Description	it Used
Soil Tests	Fater content Test	basis of in a neering	ccant such as gel), container tray, laboratory dish with cover), balance
			<pre>/, weighing capacity ttiveity of 0.1g; or 0.000g and reciprocal nnstant temperature anitain inside</pre>
	Specific Weigth	To determine specific weigth (density) of soil. Trimmer, Wire saw, miter box, stright edge. Specific weigth is used to calculate dead weitht glass, spatula, vernier calipers (accuracy : of soil that is required for design calculation, 1/200mm)	c, stright edge, plate (pers (accuracy :
	Specific Gravity Test for Soil Particles	To determine the averge specific weight of soil Phicnometer (3), balance (weight capacity of 200g particles forming a soil skeleton, which is and reciprocal sensitivity of 0.001g), thermomete required to determine basic properties of soil (calibrated scale: 1° C), jeater, pad, evaporatin such as void ration, saturation, and compactness, dish, disccator, constant temperature drying furnace, funnel. distilled water	sight capacity of 200g of 0.001g), thermomete sater, pad, evaporatin amperature drying
·	Liquid Limit Test	To determine liquid limit, as part of soil consis Liquid limit apparatus, drainer, spatula, kitchen -tencies. Liquid limit is the minimum water aid (spatula to scrape the specimen from a brass content at which soil becomes liquefied and is an tray), glass plate (thick), sprayer, cloth, water important indicator for classification of fine content measuring device grained soil and evaluation of engineering properties of soil.	ner, spatula, kitchen specimen from a brass sprayer, cloth, water
	Plastic Limit Test	To determine plastic limit as part of soil Frosted glass plate sprayer, spatula, cloth consistencies. Plastic limit is the water glass plate for mixing, container (weighing content which represents soil's plastic condition bottle with cover). 3mm diameter bar, and we and a limit for the semisolid state, and used for content measuring device classification of fine grained soil and used for estimation of soil's engineering properties.	, spatula, cloth, .ainer (weighing meter bar, and water
· ·	Mechanical Analysis	Mechanical Analysis particles by sizes. Used for classification of measuring cylinder, sieve, beaker, constant coarse grained soil and evaluation of soil's engineering properties. Watching of 1.024/15°C), spatula, watch and stop watch, bottle for water pouring, thermometer,	Jr gravimeter, beaker, constant lydrogen peroxide solution (specific tula, watch and stop

Table 3-3 (3) Details of Model Civil Engineering Laboratory Activities

COLCOLO	PULPOSE OI IFAINING AND DESCRIPTION	Rajor Equipment Used
Permeability Test	To determine soil's permeability which is require for design and construction of bank, drainage trench and other structure by determining the	Container for constant-head permability test (mold), upper overflow orifice, water tank (to give constant water level for the bottom), mesh,
	degree of water percolation into bank and ground water tank for percolation into specimen of earth dam, river bank, reclaimed bank, or specimen container (developing tray), ra uplift to a structure to be build below ground measuring cylinder, vernier calipers, st water love	water tank for percolation into specimen, specimen container (developing tray), ranmer, measuring cylinder, vernier calipers, stop watch, balance and thormometer
Consolidation Test	ie coefficient of consolidation. In is defined as volume reduction of ated cohesive soil due to discharge of when receiving load. Used to analyze	Consolidatin test set (consolidation box, loading device, weitht, support stand for consolidation box), specimen preparation set (desiccator, trimming ring pushing device, wire saw, straight
	the amount and rate of settlement when a load is applied to cohesive soil.	edge, spatula, stop watch, rubber glove, vinyl sheet, evaporating dish, watch glass, and filter paper
Shear Box Test	To determine shear strength parameter (cohesion c angle of internal friction ¢) from shearing strength of soil The result is used for	Strain control shearing box tester (shear box (dimensions of specimen: 6cm diameter and 2cm thick)), normal force loading device, shear
	calculation of earth pressure, slop stability, and bearing capacity of structure foundation.	loading device, probe (capacity of 100 - 300kg with reciprocal sensitivity of less than 1/200).
		ular gauge lot vertical unspracement vertective length of more than 100mm, with reading scale of 1/100 - 1/200mm), filter paper (60mm diameter), and water content measuring device and specimen
	- 1	preparation device
Uncontined Compression Test	To determine unconfined compressive strength and sensitivity of cohesive soil. The result is used to determine cohesion for calculation of hearing	Strain control unconfined compression test set (force gauge, dial gauge for gorce gauge, compression board, compression handle, dial gauge
	20	for measurement of compression), specimen preparation set (miter boxes (large and sma speciment preparation set (miter boxes (lar small and wire saw)
Triaxial Compression Test	To determine shear strength parameter (cohesion c and angle of internal friction ϕ). As the	Triaxial compression test device (force gaug dial gauge for measurement of compression.
	speciment can be tested under stress and drainage near actual ground conditions, more reliable data commared to other shear tests can be obtained.	pressure chamber, specimen, piston, burette, and pressure gauge), specimen preparation device
Compaction Test	Compation is important to obtain stability of earth structures such as road bed, subgrade, and hask. To determine soil density (maximum dry	2.5kg ranner, 2.5kg ranner, 10cm mold, 15cm mold, developing tray, sprayer, standard sieves (38.1mm 25.1cm, 19.1mm, 12.7mm, 1970), specimen
	density) under water content at which the soil can be vest compacted by a specific compaction	extruding device, balance, straight edge, and water content measuring device

Table 3-3 (4) Details of Model Civil Engineering Laboratory Activities

Category

Purpose of Training and Description Rajor Equipment Used	whated by dividing test load intensity i penetration by standard load for the penetration, and indicated in termination of paving thickness or acity of ground.	straight edge, balance (weighing tagaint up zons with reciprocal sensitivity of 10g), sieve(13.1mm 4760), water content measuring device, mixing device (developing tray and sprayer), measuring cylinders (500ml or 1,000ml), water tank, spoon, filter paper, and stop watch	To determine N value, an indicator of soil Standard penetration sampler, knocking head, hardness and compactness, by using a borc hole. hammer, tonbi , boring rod, pipe wrench, folding As most of information related to ground wood rule, field book, chalk, bottle and box to conditions can be estimated from N value, the keep specimen, scaffold bottle and box to boring.	To Penetrate a cone into ground and measure butch double tube cone penetration tester relationship between the penetrated depth and (pressing and extracting gauge or force gauge), resistance, therby estimating characteristics of and fixing device (screw anchor) soil layers. Used to evaluate hardness of layers of and fixing device (screw anchor) soil layers of soil, stratification, an effect of ground improvement, and increase in shearing strength due to compaction	To measure shearing strength of clay at the field Vane and vane shaft, rod casing, measuring stand without taking a specimen. Applicable to very (handle, force gauge, and calibrated disk), and soft clay which shearing strength is affected due casing extractor to disturbance by sampling or forming a specimen.	To determine CBR value from a field penetration Load (truck, etc.), tamaza , screw jack or oil test. CBR is calculated by dividing test load jack, force gauge, penetrating piston, dial gauge intensity for a given penetration by standard fixing divice. load slab (semi-circular lead load intensity for the penetration, indicated in plate, 1.25 kg, 4 or more), stand, dry sand or bearing capacity of ground.	To apply load to a rigid loading plate at the Loading plate (steel disks of more than 22 mm field and determine the relationship between load thick with diameters of 30 cm , 40 cm, and 75 cm) and displacement. From the relationship, to pressure device, loading device, hydraulic jack
 l Purpos	CBR is calcu for a given intensity fo percentage. Used for det bearing capa		To determine hardness and As most of j conditions c test is cont boring.	To Penetrate relationshif resistance, soil layers, compactness ground impro strength due	To measure s without taki soft clay wh to disturban	To determine test. CBR i intensity fo load intensi percentage. or bearing o	To apply loa field and de and displace
Category	Indøor CBR Test		Standard Penetration Test	Static Cone Penetration Test	Field Vane Test	In-place CBR Test	Plate Bearing Test

Purpose of Training and Description	identify permeability of water-bearing layers Pumping well, the field. This test plays an important role gauge, water m developing effective measures to cope with und water at a construction site.	E H W W	To drill a hole mechanically and to estimate stratification from the drilling speed, reaction, and undisturbed samples collected, thereby to observe soil or rock forming the ground. To drill a hole for continuous collection of undisturbed samples, in-situ test, or measurement of ground water level.	To insert a thin wall tube into the bottom of a Sampling tube, sampler head set, piston set, bored hole and collect soil inside the tube as piston extension road, boring rod, wrench for a sample. Mainly used for soft clay. bil cone, chain, turn buckle, coupling to fix piston,	Le Chateller pycnomete graduation of less tha (weighing capacity of sensitivity of 0.1 g), tank (adjustable to a within $20 \pm 2^{\circ}$ C by I completed dehydrated I thermometer, evaporati	Fineness of cement is an important physical production. Blein air chuter set, balance factor to govern characteristics of cement and (weighing capacity of 100 g with reciprocal concrete, and it allows the estimation of sensitivity of 1 mg), manometer fluid, stop properties of mortar and concrete prior to watch, watch glass, writing brush, spoon, production		To check stability of cement which causes dutoclave, balance (weighing capacity of 1 kg expansive crack or deflection to concrete and with reciprocal sensitivity of 1 g), measuring deteriorates durability of structure, by cylinder, bowl and spoon for mixing, glass plate, more reference and continue to the second hand, moisture box
Category	In-place Permeability Test	In-place Specific Weight	Boring	Thin Wall Sampling	Specific Weight Test	Fineness Test	Coment Setting Test	Autoclave Soundness Test
Category					Tests Related to Concrete			

Table 3-3 (5) Details of Model Civil Engineering Laboratory Activities

Table 3-3 (6) Details of Model Civil Engineering Laboratory Activities

Category

Category	Purpose of Training and Bescription	Major Equipment Bsed
		and humidity over 80 %) and humidity over
Strength Test	To check binding force of cement actually produced. This serves as a quality inspection on cement and indicates strength of concrete using the cement.	Mixing devices, f Mixing devices, f to remove mortary (triple form to m brush to apply m edge, bamboo spat box capable of ma Mihaelis doubl automatic weighin 10 kg with recipr for marking suppo for marking suppo for small wa test piece taken test fig
Sieve Analysis Test for Aggregates	To determine grading, fineness modulus, and maximum size of coarse aggregate. Required to accept or reject aggregate, to determine adequate portions of different types of aggregate, as well as for mixture design and quality control on aggregate.	
Specific Gravity and Coefficient of Water Absorption for fine Aggregate	 To determine general properties and absolute volume of fine aggregate for mixture design Coefficient of water absorption is determined to indicated the degree of void inside fine aggregate particles and to adjust and amount of water in mixture design, while serving as one indicator of aggregate quality 	Balance (weighing capacity of 1 kg, with reciprocal sensitivity of 0.1 g), flask (500 cc at 20° C), flow cone and rammer to measure surfac drying condition (340 \pm 15 g in mass, with 25 \pm 3mm diameter circle in section at one end), sampler, water tank, dryer, desiccator, pipete, and funnel
Specific Gravity and Coefficient of Water Absorption for Coarse Aggregate	 To determine general properties and absolute volume of coarse aggregate for mixture design Coefficient of water absorption is determined indicate the degree of void inside coarse aggregate particles and to adjust an amount of water in mixture design, while serving as one indicator of aggregate quality. 	Balance (weighing capacity of over 5 kg, with reciprocal sensitivity of less than 0.5 g, capable of measuring nominal weight in water), mesh cage (made of less than 3 mm mesh. 20 cm in diameter and 20cm in height), water tank, dryer desiccator
Specific Weight and Solid Volume Percentage	Required for concrete mixing, proportioning, and batching at the field.	Balance (accuracy of more than 0.2 % of total mass of specimen), specific weight measruring container, rammer, and dryer
Sruface Nater Percentage for Fine Aggregate	Sruface Water Percentage To determine possible influence of surface water for Fine Aggregate on fine aggregate upon water to be mixed with motor or concrete, and to adjust amount of water accordingly.	Balance (weighing capacity of more than 2.0 kg, with reciprocal sensitivity of reciprocal sensitivity), Chubman flask (capacity of 2 to 3 times when lightly filled, with minimum graduation at every 0.5 cc), and pipette

Activities
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Table 3-3
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0 a t < m at t	(Catagone	l Durnose of Training and Description	Maîor Fouinment Need
	Slump Test		Slump cone, rammer (16 mm diameter and 50 cm long round steel bar, with semi-spherical end), slump measurement device, watertight flat plate, scoop, and spatula
	Air Content of Fresh Concrete	As air content of concrete significantly affects properties of concrete (including durability, strength, water tigthness, specific weight), this test is conducted to measure air content of fresh concrete.	Washington type air meter and acessories, rammer (16 mm diameter and 50 cm lond round steel bar), wood hammer, and scope
	Compressive Strength Test	 (1) To determine compressive strength of concrete in a given mixture and to select a mixture suitable for obtaining the required strength (2) To check if materials (e.g., cement, aggregates, water, admixtures) is suitable for use, and to select materials which can produce concrete with required performances in the most occonneical manner 	Form for test piece production (15 cm diameter, 30 cm in height), rammer (16 mm diameter and 50 cm long round steel bar), capping glass, spatula, vernier calipers, scoop, concrete mixer and accessories, compression tester
		 (3) To estimate other performances (e.g., bending strength, tensile strength, and modulus of elasticity)from compressive strength (4) Used for quality control on concrete (5) To determine quality of concrete constructed in as actural structure and to check if it 	
		has compressive strength and other performances assumed in design. Also used to determine the time of removing the form or the time of prestressing	
	Tensile Strength Test	To determine tensile strength of concrete by placing a cylindrical test piece on its side and applying concentrated load to both ends of its diameter. Tensile strength is very important in concrete road slabs and water tanks which receive bending force directly.	Form for test piece production (15 cm diameter, 30 cm in height), rammer (16 mm diameter and 50 cm long round steel bar), capping glass, spatula, vernier calipers, scoop, concrete mixer and accessories, compression tester
	Bending Strength Test	To determine bending tensile stress on the tesile Form for test piece produciton (15 cm x 15 cm side by applying bending moment to a concrete diameter, more than 53 cm in height), rammer beam up to destruction (16 mm diameter and 50 cm long round steel bar) scale, spatula, vernier calibers, scoop, concre mixer and accessoried, compression tester	Form for test piece produciton (15 cm x 15 cm diameter, more than 53 cm in height), rammer (16 mm diameter and 50 cm long round steel bar), scale, spatula, vernier calibers, scoop, concrete mixer and accessoried, compression tester
	Mixture Design	To select mixture design which provides sufficient strength durability, water-tigthness and other performance required for a particular sturcture, and minimizes the weight of water per unit volume while maintaining sufficient workability.	Wixer (tilting type with capacity of 50 to 100 L, or forced mixer for concrete of stiff consistency), weighing scale, material containers shovel mixing plate, slump tester set, air meter set form for test piece production, curing equipment, and strength tester

Table 3-3 (8) Details of Model Civil Engineering Laboratory Activities

Tests Balated to Prevenent: Tests Participants Tests Partit Tests Participants Test	Category	l Category	Purpose of Training and Description	Major Equipment Used
(Asphilt, methods, for the set of streng of standard proto continue. Here, signal and properties after and an analysis of the set of the set of set of the set of set of the set of the set of set of the set of the set of the set of the set of set of the set of the set of set of the s	Tests Related to	•	To measure cosistency of solid or semisolid	Penetration test equipment (penetration meter,
Softening Point Test Decletion by Trobe. Softening Point test for dependence at with signal bering Softening Point tester set find, respective set hearty was, therporenets as hearty area, therporenets of some and the soften and the so	Pavement	Asphalt	asphalt, which is indicated as the degree of	standard probe, container, glass plate), constant
Test to high temperature at which state, metal place, set fring, ball, ball emperature. More precisely the guide, ring base, hearmometer, softening pinn is the temperature at which has the temperature at an event, on state, metal place, state for shep, appendix parts in the temperature at a specific distance temperature water metal place, non-state for shep, appendix period of the temperature at a specific distance temperature water math, brass plate for shep, when bing beated or state instruction (a) at which has the prometer, when bing beated or state for a specific speed as the length of extension (a) at which with the specien at a specific distance temperature water math, brass plate for shep, the specien at a specific distance temperature at the romometer, branometer, present as a separation (a) at which with the specien state of at which with the specien state of at which with the rest and mile or at a specific and to be determined to attain suitable fluidity. Flash point tester (sample cap, heating plate for shep, wind the state of some state, for an as appault is branch and the remometer budden (a) of the required to at the romometer, when being plate the specific and the remometer of flow meter. The romometer is produced and the remometer of flow meter and, and note the state of the specific and the remometer of flow meter. The state of th			penetraiton by probe.	temperature water tank, thermometer, stop watch
<pre>softening point if the processity the softening point if the processity the sets black and 'process' for Shap asphalt offens and 'process' for Shap asphalt offens and 'process' for Shap measured y pulling a specific distance theretwee wheth and 'process' for Shap measured y pulling a specime at a specific distance measured y pulling a specific distance theretwee wheth and 'process' for Shap measured y pulling a specime at a specific distance measured y pulling a specime at a specific speed as the length of extension (cm) at which weater that, and 'process' for Shap measured y pulling a specime at a specific speed as the length of extension (cm) at which weater that' and 'process' state and 'process' state the fish point needs to be determined to avoid all support for heating plate the fish point needs to be determined to avoid all support for the state the fish point needs to be determined to avoid all support for the state fire heard fire heard for determine if asphalt emulasion has required for distance port to that ergon and in specific anount (50 cc) at a specific the fire heard for distance port to that ergin a support for the momenter wolf and stop watch' state port to that ergon and find stop watch' for and a support for the degree of find atom and the state' flage plate, flage port to the ergon and indicators port to that ergon and indicators port to the ergon of aphalt Test piece extraction. Marshall tester (load mitture for parteent argins displacement upon less and to determine the degree of fishance by connecting the maximum agregates fire of 25 mm of the store. Proton yours of a and it' vid, then lad and displacement upon less, and to determine the destruct upon of void, then lad and displacement upon for void, then lad and displacement upon advoid then lad and displacement upon entrance bashing contain test Extraction test for ther, of nore than 5 ks, test in terms of quality content by the extraction test for early of a state of and with the state of the state of and inspection bashalt inter</pre>				Softening point tester set (ring, ball, ball
<pre>systeming softening softening specific distance tametary plate, stop watch, constant tamper specific distance tametary plate for shaps when being theaten durinity the soften durinity the stert. form, weaks the length of extension (cm) at which is provide symphic softens and drinfe constant tamperature set thermometer; constant temperature set as the length of extension (cm) at which is provide symphic test for durinity the stert. Intromometary is a specific and thermometer; constant temperature set as the length of extension (cm) at which is provide symphic test for durinity. Flash point test (sample cap, heating plate, the specific another set is indicated by ratio of time required for constant temperature water tank, stop watch, the strenger is indicated by ratio of time required for constant temperature water tank, stop watch, a specific temperature of for out of discharge to another for its and stop state. For the state is indicated by ratio of time required for constant temperature water tank, stop watch, a specific temperature for out of discharge to another for its and stop state. For the state is indicated by ratio of time required for constant temperature water tank, stop watch, specific temperature for low of and stop state. For its indicated by ratio of time required for constant temperature water tank, stop watch, is specific temperature for discharge to the state soften state. For out out under the same conditions. The state set (store state, set (lore tan is specific temperature state is of 101.6 in the discharge biese with store state upon and is place for state. State of 101.6 in the store state state state is state. The state is indicated by the extinet stop water to show the state state of 101.6 in the discharge biese with store state and state. The stop is shown to the state state of 101.6 in the store state stop store is indicated stops and stop stop stop is stop store in the state stop store is indicated stops and stop stop is stop is stop is to the stop stop is stop stop is stop is st</pre>		for Asphalt	to high temperature. More precisely, the	guide, ring base, heating vane, thermometer,
 asshilt softna and drips to a specific distance temperature water make, brass plate for shap. assared by hulling a specific conditors. to determine ductility of saphile for an which is metal plate, thermometere), constant temperature specific specific specific at which is the specific specific specific at the specific specifi			softening point is the temperature at which	heater, metal plate), stop watch, constant
With being head under Spedific conditionsEarle for Stabing and Weeter, form accounted by pulling a specific conditionsEarle for Stabing and Weeter, form and huitetTo determine durcility to c sophilic conditionsEarle for Stabing and Weeter, form and huiteseasured by pulling a specimen at a specificmetal plate, thermometer, constant temperation appear in the specific branch is the specific stabing plate, theater; thermometer if the haze of a train suitable fluidity.tAs apphait is heated to attain suitable fluidity.the specimen is brokenstred, findthe specimen is provid a support for heating plate, theater; thermometer if the haze in specific amount (set) and stop watch.estTo determine if asymather multication (an) at whichthe specimen is specific temperature to flow out of discharge point to the required for dester tester set (angler meter, sibled, and stop watch, receiver), a specific temperature to flow out of discharge point to the required for distiled water to flowity Test To determine the degree of creation (and plate, meter tah, stop watch, as to build be about stopil tester (load out under the sequed for dester set (and plate, meter tah, stop watch, as to build be about stopil tester (load to determine the degree of applate thest plece of the noise of applate and percention for a strainer (south the stabil tester (load to the stop) and height and to constant to a stop of 101.0ity Test To determine the degree of applate and prove (under the stade, the about stop of 102.0ity Test To determine the degree state contraction water tank, stop watch as to contact the stade, the stade about a dester test plate, dester (200 °C)ity Test To determine the degree state of dester set			asphalt softens and drips to a specific distance	temperature water tank, brass plate for shaping,
<pre>to determine of stain symbat, much is puctificy test set, vortuinty of saphat, mark assured by pulling a specific at which the flash point needs to be determined to avoid a support for heating plate, heater, thermometa speed as the length of extension (cm) at which the flash point needs to be determined to avoid a support for heating plate, heater, thermometa the flash point needs to be determined to avoid a support for heating plate, heater, thermometa the flash point needs to be determined to avoid a support for heating plate, heater, thermometa the flash point needs to be determined to avoid a support for heating plate, test flame azzle), whid similar strated by ratio of time required for constant temperature water tank, stop watch, degree is indicated by ratio of time required for constant temperature water tank, stop watch, a specime in specific amount (50 cc) at a predictic temperature to flow out of discusse port to time required for distilled water to flow intrume for portune to flow out of discusse port to time required for distilled water to flow as specimen in specific amount (50 cc) at a predictic temperature water tank, stop watch, as specime the same conditions ity Test is an equired for distilled water to flow out under the same conditions ity Test is denoted by the vater to flow determine the maximum agreede as the to test is and and height of 76.2 mm, abotton plate, collored out under the maximum agreede as burner), constant temperature water tank, as to we out and height of 76.2 mm, and height of 76.2 mm, abotton plate, fold of destruction and displacement upon destruction test fractoring the stand and the stand of void, then lead and displacement upon destruction test for the stand of a stand, would be destruction test for the stand of a stand, and the stand destruction test is to maxim as the stand with a stand would be destruction test if it comples with destruction test for the stand test. In terms of quality control and inspection ton asphalt mixture with destant important to stand s</pre>			when being heated under spedific conditions.	knife for shaping, and tweezers
the speciment by putting a spectruc metal pare, therefore, test flame point tester, therefore, the flame point the speciment is broken at a spectruc metal pare, therefore, the flame point the speciment is broken. the flash point needs to be determined to avoid a support for heating plate, heater, thermoeter, the speciment is broken. the flash point needs to be determined to avoid a support for heating plate, heater, thermoeter, the speciment is broken. the flash point needs to be determined to avoid a support for heating plate, heater, thermoeter heater, the speciment is provide or mixed. Engler meter, test flame point tester (segments), use the speciment is specific anowned or mixed. Engler meter, thermoeter holder, the same conditions is provide the same conditions. to deret is indicated by ratio of time required for constant temperature water tank, stop watch, a speciment in specific anown (so col at a support for heating plate, receiver). thermoeter of flow out of discharge port to flow meter is a speciment by a specific temperature to flow out of standard strain ring. flow meter to flow the to use unit under the same conditions. Ify Test is defined for a disclusive of to flow meter to flow to the same conditions and height of flow meter of 101.6 to constant temperature water tank, stop watch, a specime is a disting the maximum stream strain and height of flow meter of 102.6 to constant temperature water stand. For the same conditions is to compact the maximum stream strain and height of flow meter of 102.6 to constant termine the set derest of 102.6 to the same of the maximum stream strain and height of flow meter of 102.6 to constant temperature water stand. For the standard strain ring. flow meter is and to determine the set of set of the maximum stream strain and height of flow meter of 102.6 to set of the maximum stream strain and height of flow meter of 102.6 to set of the maximum strains and height of flow meter of the antime strain strain strain and heigh		Ductillity lest	10 determine ductility of asphalt, which is	Puctificy test set (querilary tester, lora,
 the starting between a strain of the fluidity. Flash point tester (sample cap, heating plate the flash point needs to attain suitable fluidity. Flash point tester (sample cap, heating plate the flash point needs to be determined to avoid a support for heating plate, heater; thermometing the flash point needs to be determined to avoid a support for heating plate, heater; thermometing to be determined to avoid a support for heating plate, heater; thermometing work the flash point needs to be determined to avoid a support for heating plate, excepted to attain specific amount (50 cc) at a specime taper tank, stop watch, a specime in specific amount (50 cc) at a specime (340 mm sieve) ity Test To determine the same conditions taken to flow out of discharge port to the same conditions take a stimate the same conditions to avoid the same conditions to avoid the same conditions to avoid the same approace to the same conditions to avoid the same conditions to the same conditions to the same conditions to avoid the same conditions to the same conditions to the same to flow out of a same to flow to the same conditions to the same conditions to the same conditions to the same tage store, build matter to flow to the same store take flow to the same time take as the same time take as the same time take the same take as the same time take the same take as the same time take as the same time take the same take as the same time take take as the same time take take as the same take take take as the same take take take as the same take take take tak			Reasured by pulling a succument at a specific enced as the loweth of extension fem) at which	metar prate, incrnometer), constant temperature matar tank and baifa
 t hs ashalt is heated to attain suitable fluidity? Flash point tester (sample cap, heating plate metary intrometion the flash point, needs to be determined to avoid a support to heating plate, metary. Intrometion the flash point needs to be determined to avoid a support to heating plate, metary. Internometer holder, test flame point), wind fire hazard. the flash point, needs to be determined to avoid a support to heating plate, metary. The metary is present to the determine if asphalt emulasion has required for super to the set. Fause point), wind degree is indicated by ratio of time required for constant temperature water tank, stop watch, a speciant in specific amount (50 cc) at a strainer (840mm sieve) metary. Faceivery. ity Test To determine the degree of asphalt Test place extractor, Marshall tester (Joad a ut undet the same avointions in specific amount (50 cc) at a and height of 78.2 mm. bottom plate, collore port to time required for displacement due to flow (or whether with the dimeter of 100 metal containing the maximum aggregate size of 28 mm or compaction hammer, compaction stand, mold for set and to determine its density and portange there is a store, busine its density and percentare heater st (dryrer, heating plate, collore is and to determine its density and portange there set (or or 0.016, 100 molds) estimates at the set and the ight of 78.2 mm. bottom plate, for 00 molds is store, busines the set and and displacement upon and heating there set (or 0.016, 0.016, 0.016, 0.03, 0.15, 0.03, 0.15, 0.03, 0.16, 0.16, 0.16, 0.16, 0.16, 0.03, 0.16	-		the specimen is broken	ATTR 500 - 100 - 100
<pre>the flash point needs to be determined to avoid a support for heating plate, heater: thermomet fire hazard. fire haza</pre>		Point	As asphalt is heated to attain suitable fluidity,	Flash point tester (sample cap, heating plate,
fire hazard. fire hazard. fire hazard. fire hazard. for determine if asphalt emulation has required for indicated by ratio of time required for indicated by ratio and super to the remometer wood plug, heater, stop watch, a specific temperature bo low out out of discharge by an out under the same conditions port to time required for indicated water to flow anter tamk, stop watch, a specific temperature bo low out out on the required for indicated by ratio for out on the ratio of the same conditions ity Test To determine the degree of resistance of folo. Ity Test To determine the degree of resistance of apphalt test plece with indicate set (offer the ratio strain ring, flow meter indicated and the maximum aggrees of 25 mm or compaction hammer, compaction stand, mold ho less, and to determine its density and percentage heater set (dryer, heating and, sover, one is based size set of an or compaction hammer, contain stand, and heater set (dryer, heating and, sover, and destruction is based size of 10.5, 0.3, 0.3, 0.4, 0.4, 0.16, 0.3, 0.4, 0.5, 0.3, 0.4, 0.4, 0.5, 0.3, 0.4, 0.4, 0.4, 0.4, 0.4, 0.4, 0.4, 0.4			the flash point needs to be determined to avoid a	support for heating plate, heater, thermometer,
<pre>st To determine if asphalt emulasion has required Engler dester set (engler meter, cohesion when being sprayed on ixed. Engler dester set (engler meter, cohesion when being sprayed on ixed. Engler dester set (engler meter, cohesion when being sprayed on ixed. Engler dester set (engler meter, cohesion when being sprayed on ixed. Engler dester solutions the specific temperature to flow out of distances port to time required for distilled water to flow out of distance (addmention size) is precific temperature to flow out of distances port to time required for distances of asphalt test piece extractor. Marshall tester (load mixture for parement against displacement due to for (sylinder with inner diameter of 101.6 load mixture for parement against displacement due to for (sylinder with inner diameter of 101.6 load is to produce a cylindrical test piece by form (sylinder with inner diameter of 101.6 loss, and to determine its density and percentage heater set (dryer, heating plate, gas stove, less, and to determine its density and percentage heater set (dryer, heating plate, gas stove, struction less, and to determine its density and percentage heater set (dryer, heating plate, gas stove, less, and to determine its density and percentage heater set (dryer, heating plate, gas stove, struction test it compared size size 01, 2.5, 5, 13, 20, 25 mm), thermometer (200 °C) stove is balance wighing capacity of 5 kg, test in terms of quality contrant test prices by the extraction test lift or see if it comples with displacement upon the inter struction test lift of the sector of its of less, test is the sector of the sector set of 10.6 gor less). If is on asphalt mixture. To measure asphalt content by the extraction test kircution test kircution test kircution test is to praser set of of sector of is on asphalt nik wure. To measure asphalt content by the extraction test kircutor balance schere of 0.6, sector of 0.6,</pre>			fire bazard.	thermometer holder, test flame nozzle), wind
<pre>contermine if asphale enulasion has required fingter degree tester set tenger meter, cohesion when being sprayed or mixed. Engler thermometer worker tank, stop watch, a specimen in specific amount (50 cc) at a strainer (340mm sieve) tenger frain ring; frow meter port to time required for distinct distance of asphalt Test piece extractor. Marshall tester (load ity Test To determine the degree of resistance of asphalt Test piece extractor. Marshall tester (load mixture for pavement against displacement due to tester) loading head is strain ring; frow meter load. To produce a cylindrical test piece by test container diameter of 101.6 to mixture for pavement against displacement due to tester) loading head is strain ring; frow meter load. To produce a cylindrical test piece by and height of 76.2 mm, bottom plate, collored containing the maximum aggregate size of 25 mm or compaction bammer. compaction stand, mold ho less, and to determine its density and percentage heater set (dryer, heating plate, gas stove, of void, then load and displacement upon destruction back and displacement upon for to master set (dryer, heating plate, for fess), fit heating agregates, container for heating asis, heating agregates, container for heating asis, test in terms of guality control and inspection test Extraction test Extraction test est (form and heating agregates, container for heating asis, test in terms of guality control and inspection to see if it complies with design. Important to see if it complies with design. Important test in terms of guality control and inspection test in terms of guality control and inspection to asphalt mixture. Standard sieve, set und, scale for analysis, heating trans, trans, set as a burner, desict on asphalt mixture (2,000 cc), steaming tray, used, go ress), fit destruction asphalt with design. Important tray, beaker, spatula, scoop, and destruction test for tray beaker, spatula, scoop, and destruction and inspection test former, tray, beaker, spatula, scoop, and destruction and inspection te</pre>				shield, and stop watch
<pre>fonestion when being sprayed or mixed. Engler theraometer wood plug, header, receiver), degree is indicated by ratio of time required for constant temperature water tank, stop watch, a specific temperature to flow out of discharge port to time required for distilled water to flow a ut under the same conditions out under the same conditions inviture for pavement against displacement due to tester, loading head, strain ring, flow meter pout to the required for distilled water to flow out under the same conditions inviture for pavement against displacement due to tester, loading head, strain ring, flow meter pout, not any maximum against displacement due to tester, loading head, strain ring, flow meter load. To produce a cylindrical test piece by form (cylinder with inner diameter of 101.6 load. To produce a cylindrical test piece by form (cylinder with inner diameter of 101.6 less, and to determine its density and percentage heater set (dryer, heating splate, collored containing the maximum aggesize of 2 mm or compaction stand, mold hous less, and to determine its density and percentage heater set (dryer, nome, tent tank, as) destruction for void, then load and displacement upon destruction for to see if it complies with design. Important furnace, balance (weighing capacity of 5 kg, test in terms of guality control and inspection test Extraction tester set (bowl, centrifuge), dri test in terms of guality control and inspection to see if it complies with design. Important test in terms of guality control and inspection test if y terms of guality control and inspection test for test, the weature tray, besker, sputua, scole test test of test test in terms of guality control and inspection test of the test test of the test for te</pre>		Degree	To determine if asphalt emulasion has required	Engler degree tester set (engler meter,
for the transforment of the sequenced for constant temperature water tank, stop watch, specific temperature to flow out 65 cc) at a specific temperature to flow out 65 cc) at a prot to time required for distinct a strain ting; flow meter port to time required for distinct a strain ting; flow meter inty Test To determine the degree of resistance of asphalt Test piece extractor. Marshall tester (load mixture for parement against displacement up to tester, loading head; strain ting; flow meter load. To produce a cylindrical test piece by form (cylinder with inner diameter of 101.6 compacting hor-laid mixture asphalt compound and height of 76.2 mm, bottom plate, collored containing the maximum aggregate size of 25 mm or compaction hammer, compaction stand, mold ho less, and to determine its density and percentage heater set (dryer, heating plate, collored its, then load and displacement upon destruction for void, then load and displacement upon destruction for void, then load and displacement upon and reciprocal sensity of more than 5 kg, the atting aggregates; container for heating as balance weighing capacity of 5 kg, the time asphalt content by the extraction test Extraction tester set (bowl, centrifue), dri to see if it complies with design. Important to see if it complies with design. Important test in terms of guality control and inspection test in terms of guality control and inspection test in terms of guality control and inspection to see if it complies with design. Important to see if it complies with design. Important terms to paper; weighing scale for analysis, test in terms of guality control and inspection ting or paper; weighing tray, besker, spatula, scoop, and the scheme tray, besker, spatula, scoop, and the scheme tray besker, spatula, scoop, and			conesion when being sprayed or mixed. Engler	
a specimena strainer (840mm sieve)specific temperature to flow out of dischargestrain flow out of dischargeport to time required for distlied water to flowstrain ring; flow meteiport to time required for distlied water to flowflow out of dischargeport to time required for distlied water to flowflow out of dischargeport to time required for distlied water to flowflow out of dischargeport to time required for displacement due to tester, loading head; strain ring; flow meteiwitture for pavement against displacement due to tester, loading head; strain ring; flow meteiwitture for produce a cylindrical test piece byflow flow flow out of 76.2 mm, button plate, collorecompacting hot-laid mixture saphalt compoundand height of 76.2 mm, button stand, mold hoload. To produce a cylindrical test piece byflow out of 76.2 mm, button stand, mold hoload. To produce a cylindrical test piece bybutner), constant temperature water tank, ascontaining the maximum agregate size of 25 mm or compaction hammer, compaction stand, mold holess, and to determine its density and percentage heater set (dryer, heating plate, collore, butner flomof void, then load and displacement upon2.5, 5, 13, 20, 25 mm), therameter water tank, asdestructionand heater stand straing agregates, container flowtest in terms of quality control and inspection test Extraction tester set (dryer, beschrege), dryfortest inf terms of quality control and inspectionfortest inf terms of quality control and inspectionfortest in terms of quality control and inspectiontest in			degree is indicated by ratio of time required for	
 specific temperature for flow out of discharge port to time required for distilled water to flow port to time required for distilled water to flow port to time required for distilled water to flow port to time required for distilled water to flow port to time required for distilled water to flow port to time required for distilled water to flow port to time required for distilled water to flow port to the same conditions. ity Test To determine the degree of resistance of asphalt Test piece extractor. Marshall tester (load mixture for pavement against displacement due to tester, loading head, strain ring, flow metal watture for pavement against displacement due to compaction hamber, compaction hamber, compaction stand, mold ho less, and to determine its density and percentage heater set (dryer, heating plate, gas stove, of void, then load and displacement upon burner), constant temperature water tank, asi destruction the maximum agregate size of 25 mm or compaction hamber, container for heating agregates, container for heating agregates, container for heating agregates, container for provel, then load and displacement upon mixer. Standard sieves (0.074, 0.15, 0.3, 0.3, 0.5, 13, 20, 25 mm), thermometer (200 °C), shovel, gloves (rubber, cotton), container for heating agregates, container for neuting tray (loss of grand), container for heating agregates, container for heating and inspection test furnace, balance (weighing control and inspection test furnace, balance (weighing scale for analysis, on asphalt mixtu			a specimen in specific amount (50 cc) at a	
<pre>port to the required for distlined water to 1104 ity Test T determine the degree of resistance of asphalt Test piece extractor. Marshall fester (load mixture for parement against displacement due to tester, loading head, strain ring; flow meter load. To produce a cylindrical test piece by form (cylinder with inner diameter of 101.6 for compacting hot-laid mixture asphalt compound containing the maximum aggreate size of 25 mm or compaction hanner, compaction stand, wold ho less, and to determine its density and percentage heater set (dryer, heating plate, gas stove, of void, then load and displacement upon less, and to determine its density and percentage heater set (dryer, heating plate, gas stove) best, then load and displacement upon destruciton need to determine its density and percentage heating aggregates, container for heating as burner), constant temperature water tank, as i destruciton need to displacement upon nixer, standard sieves (0.074, 0.15, 0.3, 0.1 2.5, 5, 13, 20, 25 mm), thermometer (200 °C), then load and displacement upon nixer, standard sieves (0.074, 0.15, 0.3, 0.1 2.5, 5, 13, 20, 25 mm), thermometer (200 °C), the standard sieves (bowl, centrifuge), dry heating aggregates, container for heating as balance weighing capacity of more than 5 kg, teciprocal sensitivity of 1.0 g or less), fit on asphalt mixture. To measure asphalt control and inspection test in terms of guality control and inspection test to see if it complies with design. Important tray, beaker, standard sab burner, desice heating tray (125 cc), measuring cylinder the stand for heating true, spather, desice the standard section test, the standard section test, the standard section test. The standard section test, spather, spather, spather, spather, spather, desice the standard section the stand</pre>			specific temperature to flow out of discharge	
ity Test To determine the same conditions ity Test To determine the degree of resistance of asphalt Test piece extractor. Marshall tester (load mixture for pavement against displacement due to tester, loading head, strain ring, flow meter load. To produce a cylindrical test piece by compacting hot-laid mixture asphalt compound containing the maximum aggregate size of 25 mm or compaction hammer, compaction stand, mold ho less, and to determine its density and percentage heater set (dryer, heating plate, gas stove, of void, then load and displacement upon destruction To measure asphalt compound to mixer, standard sizes (0.074, 0.15, 0.3, 0.3 destruction To measure asphalt content upon nixer, standard sizes (0.074, 0.15, 0.3, 0.3 destruction To measure asphalt content by the extraction test farture with more than 5 kg, to measure asphalt content by the extraction test farture verify of 5 kg, test in terms of quality control and inspection test in terms of quality control and inspection on asphalt mixture. To measure upton test for analysis, test in terms of quality control and inspection test in terms of quality control and inspection traine or paper, weighing scale for analysis, test in terms of quality control and inspection traine or paper, weighing scale for analysis, test in terms of quality control and inspection traine or paper, weighing scale for analysis, heating tray (125 cc), measuring cylinder to on asphalt scoop, and			port to time required for distified water to flow	
 In the second second to the second second second second strain ring, flow metal matter of 101.5 for the second second second strain ring, flow metal matter for produce a cylindrical test piece by and height of 76.2 mm, bottom plate, collored containing the maximum aggregate size of 25 mm or compaction hammer, compaction stand, mold ho less, and to determine its density and percentage heater set (dryer, heating plate, gas stove, bestruction and displacement upon mixer, standard sieves (0.074, 0.15, 0.3, 0.3, 0.4, then load and displacement upon the mater set (dryer, heating plate, gas stove, of void, then load and displacement upon mixer, standard sieves (0.074, 0.15, 0.3, 0.3, 0.4, destruction and displacement upon gerer set (dryer, heating voltaner for heating ast for void, then load and displacement upon the set of sieves (0.074, 0.15, 0.3, 0.4, destruction as the set of sieves (0.074, 0.15, 0.3, 0.4, sieves), destruction as the set of sieves (0.074, 0.15, 0.3, 0.4, sieves), destruction as the set of sieves (0.074, 0.15, 0.3, 0.4, sieves), for heating ast best as stoves, beauter asphalt content by the extraction test Extraction test restriction test of mating set (bowl, central for heating ast interms of quality control and inspection for test for of set of set of analysis, to nashalt mixture. for to see if it complies with design. Important for paper, weighing scale for analysis, to nashalt mixture. on asphalt mixture. on asphalt mixture (2000, co), steaming tray, beaker, spatula, scoop, and the set of the se			UNL URVER UNE SAME CONDITIONS	Post nicos autreatan Mercheil tester (load
 Iond. To produce a cylindrical test piece by form (cylinder with inner diameter of 101.6 the compacting the maximum aggregate size of 25 mm or compaction hammer, compaction stand, mold ho containing the maximum aggregate size of 25 mm or compaction hammer, compaction stand, mold ho less, and to determine its density and percentage heater set (dryer, heating plate, gas stove, of void, then load and displacement upon mixer, standard sieves (0.074, 0.15, 0.3, 0.4 destruction the load and displacement upon mixer, standard sieves (0.074, 0.15, 0.3, 0.4 destruction the load and displacement upon mixer, standard sieves (0.074, 0.15, 0.3, 0.4 destruction the load and displacement upon mixer, standard sieves (0.074, 0.15, 0.3, 0.4 destruction test the struction test standard sieves (container for heating as barvel, ghoves (rubber, cotton), container for heating as barvel. To measure asphalt content by the extraction test Extraction test sensitivity of 1.0 g or less). for to see if it complies with design. Important furnace, balance (weighing capacity of 5 kg, test in terms of quality control and inspection test Extraction test weighing capacity of 5 g or less). for asphalt mixture. (2.000 co), steaming tray, beaker, spatula, scoop, and the destruction tray, beaker, spatula, scoop, and the destruction test tray. 			ru ustammus tus useeve or resistance or aspuste mitting for navament anainer dissistant due fo	reau preve extravious maisueus teater (sour tates loading head strain ring floumeter)
 four to produce a cylinarization with height of 76.2 mm, bottom plate, collored compacting hot-laid mixture asphalt compound and height of 76.2 mm, bottom plate, collored iess, and to determine its density and percentage heater set (dryer, healing plate, gas stove, of void, then load and displacement upon mixer, standard sieves (0.074, 0.15, 0.3, 0.6, 2.5, 5, 13, 20, 25 mm), thermometer (200 °C), shovel, gloves (rubber, container for heating asi between the set in a set and set asphalt container the set and percentage heaters standard sieves (0.074, 0.15, 0.3, 0.6, 13, 20, 25 mm), thermometer (200 °C), shovel, gloves (rubber, container for heating as between the set and set asphalt content by the extraction test Extraction tester set (dryer, or fast), driver to see if it complies with design. Important reciprocal sensitivity of 1.0 g or less), fit rest in terms of quality control and inspection test furnace, balance (weighing capacity of 5 kg) on asphalt mixture. for asphalt mixture. 			PARALUSE NOT POTERELE SEGLIESE LINE AND ACCOUNT AND	COUNTY TORATIO NORTH JUSTICAL TIMON THOM MACUNES
 for To measure asphalt control and inspection temperature water tank, asi destruction for To measure asphalt content by the extraction test (dryer, heating plater set (dryer, heating plater tank, asi mixer, standard steves (0.074, 0.15, 0.3, 0.1 mixer, standard steves (dryer, heating plater for heating asi destruction for to measure asphalt content by the extraction test Extraction tester set (bow), centrifuge), dry to see if it complies with design. Important for to see if it complies with design. Important furnace, balance (xeighing scale for measure, desicn, on asphalt mixture. for to see if it complies with design. Important furnace, balance (xeighing scale for analysis, near tank on asphalt mixture. for to see if it complies with design. Important furnace, balance (xeighing scale for analysis, near tank on asphalt mixture. for to see if it completed and inspection test for analysis. for to see if it completer into the extraction test for analysis. 			LUGU. TO PROQUES A CYLINGITICAL CESC PIECE UP romosofing hot-loid mivture senhalt compound	LOEW (CYLLIGHE MILL FILLET ULAWECEL OF LOIN WH and baight of 78 2 mm battom mista railorad)
 For the maximum aggregates are we so must burner), comparison temperature water tank, asy of void, then load and displacement upon burner), constant temperature water tank, asy destruction then load and displacement upon mixer, standard sieves (0.074, 0.15, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.15, 0.3, 0.1, 0.3, 0.1, 0.15, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.3, 0.1, 0.15, 0.3, 0.1, 0.3, 0.1, 0.15, 0.3, 0.1, 0.3, 0.1, 0.15, 0.3, 0.1, 0.3, 0.1, 0.15, 0.3, 0.1, 0.15, 0.3, 0.1, 0.15, 0.3, 0.1, 0.15, 0.3, 0.1, 0.5, 0.3, 0.1, 0.5, 0.3, 0.1, 0.5, 0.3, 0.1, 0.15, 0.3, 0.1, 0.15, 0.3, 0.1, 0.15, 0.3, 0.1, 0.15, 0.3, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.1			οναιμαρική μοι-ταιμα μην. στητογραγίο ουραστο ουνγομής	はいち いでものいし ひと くじょう ぶかい ひつうちつき アナキクマイ くびょうべき イント
 of void, then load and displacement upon burner), constant temperature water tank, asy destruction of void, then load and displacement upon burner), constant temperature water tank, asy destruction destruction destruction 25, 5, 13, 20, 25 mm), thermometer (200 °C), shovel, gloves (rubber, cotton), container for heating asy balance weighing capacity of 1.0 g or less) for To measure asphalt content by the extraction test Extraction tester set (bowl, centrifuge), drives to see if it complies with design. Important for to see if it complies with design. Important furnace, balance (neighing scale for less), ring on asphalt mixture. on asphalt mixture. for container for paper, weighing scale for analysis. for tray (125 cc), measuring control, design, the extraction for container for paper, weighing scale for analysis. 			VUITAILLIR LIF HAALMUR ASSIVSAUE JACE VE 23 NUM UL See and to determine its density and nerventage	vuevection nemet, vuevectou scene, east usters heater set (froor heating blate gas stove gas
 destruction <lidestruction< li=""> destruction destruction <lide< td=""><td></td><td></td><td>read and to account to account where per concerning to the per concerning the set of and discharged income</td><td>hurner) constant temperature water tank asphalt</td></lide<></lidestruction<>			read and to account to account where per concerning to the per concerning the set of and discharged income	hurner) constant temperature water tank asphalt
For To measure asphalt content by the extraction test is container for heating asphare to measure asphalt content by the extraction test growes (rubber, cotton), container for heating asphalt content by the extraction test Extraction tester set (bowl, centrifuge), drives in terms of guality control and inspection test container for measure, and inspection test in terms of guality control and inspection testing tray (125 cc), measuring cylinder on asphalt mixture.			destruction	mixer standard sieves (0.074, 0.15, 0.3, 0.6.
for To measure asphalt content by the extraction test Extraction tester set (bowl, centrifuge), drives (rubber, cotton), container for heating aspect to measure asphalt content by the extraction test Extraction tester set (bowl, centrifuge), drives to see if it complies with design. Important furnace, balance (weighing capacity of 5 kg, test in terms of guality control and inspection reciprocal sensitivity of 0.5 g or less). To measure in terms of guality control and inspection test ing or paper, weighing scale for analysis, heating tray (125 cc), measuring cylinder (esich tester), steaming tank, gas burner, desicn the tray, beaker, spatula, scoop, and the set of				2.5, 5, 13, 20, 25 mm), thermometer (200 °C),
for To measure asphalt content by the extraction test Extraction tester set (bowl, centrifuge), dr. reciprocal sensitivity of 1.0 g or less) to see if it complies with design. Important furnace, balance (weighing capacity of 5 kg, test in terms of quality control and inspection reciprocal sensitivity of 0.5 g or less), fi n asphalt mixture. (2,090 cc), steaming tank, gas burner, desicn development tray, beaker, spatula, scoop, and				shovel, gloves (rubber, cotton), container for
for To measure asphalt content by the extraction test Extraction tester set (bowl, centrifuge), dr. reciprocal sensitivity of 1.0 g or less) dr. to see if it complies with design. Important furnace, balance (weighing capacity of 5 kg, test in terms of quality control and inspection reciprocal sensitivity of 0.5 g or less), fil on asphalt mixture. It control and inspection testing tray (125 cc), measuring cylinder (2,090 cc), steaming tank, gas burner, desicn and beside the tray, beaker, spatula, scoop, and				heating aggregates, container for heating asphalt
for To measure asphalt content by the extraction test Extraction tester set (bowl, centrifuge), dr. to see if it complies with design. Important furnace, balance (weighing capacity of 5 kg, test in terms of quality control and inspection reciprocal sensitivity of 0.5 g or less), fil on asphalt mixture. In the extraction test in tray (125 cc), measuring cylinder (2,090 cc), steaming tank, gas burner, desic burner, desich				balance weighing capacity of more than 5 kg. with
Ior to measure asphalt content by the extraction tester set (bowl, centrilge), art to see if it complies with design. Important furnace, balance (weighing capacity of 5 kg, test in terms of quality control and inspection reciprocal sensitivity of 0.5 g or less), fil on asphalt mixture. It control and inspection the tray (125 cc), measuring cylinder (2,090 cc), steaming tank, gas burner, desict heating tray, beaker, spatula, scoop, and				
to see it it complies with design. important durinace, balance (weighing capacity of 9.5 g or less), fill test in terms of quality control and inspection reciprocal sensitivity of 0.5 g or less), fill on asphalt mixture. It control and inspection trans of 125 cc), measuring cylinder (2,090 cc), steaming tank, gas burner, desict development tray, beaker, spatula, scoop, and			To measure asphalt content by the extraction test	, a
on asphalt mixture. ring or paper, weighing scale for analysis, heating tray (125 cc), measuring cylinder (2.090 cc), steaming tank, gas burner, desiccato development tray, beaker, spatula, scoop, and		ATTAL ATTAL	to see it it complies with design, impurant test in terms of anality control and inspection	2 4
heating tray (125 cc), measuring cylinder (2.000 cc), steaming tank, gas burner, desiccato development tray, beaker, spatula, scoop, and			on asphalt mixture.	ring or paper. weighing scale for analysis,
(2.090 cc), steaming tank, gas burner, desiccator development tray, beaker, spatula, scoop, and				heating tray (125 cc), measuring cylinder
development tray, beaker, spatula, scoop, and				(2,090 cc), steaming tank, gas burner, desiccator
				development tray, beaker, spatula, scoop, and

Table 3-3 (9) Details of Model Civil Engineering Laboratory Activities

Mixture Design Abrasion Test Tensile Streng		-	Major Equipment Used
Abrasion 7 Tensile St	sign	mixture with high stability, sion resistance, durability, and sing Marshall stability testing mixture is produced by hot-laid coarse and fine aggregates, it.	Same as marshall tester set
Tensile St	est	To determine if coarse aggregate can be used for concrete requiring abrasion resistance	Balance (weighing capacity of more than 5 kg, with reciprocal sensitivity of 1 g), standard sieve set (1.7, 2.5, 5, 10, 15, 20, 25, 40, 60, 80 mm), steel balls (6 to 12 balls having 1.74 cm diameter and 390-445 g in weight each), Los Angeles tester
Concrete	Strength Test fo	To determine testie strength of concrete by placing a cylindrical test piece on its side and applying concentrated and to both ends of its diameter. Tensile strength is very important in concrete road slabs and water tanks which receive honding force directly.	Form for test piece production (15 cm diameter 30 cm in height), rammer (16 mm dameter and 50 cm long round steel bar), capping glass, spatula, vernier calipers, scope, concrete mixer and accessories, compression tester
Bending stre for Concrete	Bending strength Test for Concrete	To determine bending tesile stress on the tensile side by applying bending moment to a concrete beam up to destruction	Form for test piece produciton (15 cm x 15 cm diameter, more than 53 cm in height), rammer (16 mm diameter and 50 cm long round steel bar), scale, spatula, vernier calipers, scopp, concrete mixer and accessories, compression tester
Indoor CBR Test	Test	CBR is calculated by dividing test load intensity for the penetraition, and indicated in percentage used for determination of paving thickness or bearing capacity of ground	
			(1.23 Ag, read, more than a units), expansion measuring device, specimen extruding device, cutter, straight edge, balance weighing capacity of 20 kg, with reciprocal sensitivity of 10 g, sieve (19.1 mm, 4760), water content measuring device mixing device (developing tray and sprayer), measuring cylinders (500 ml or 1,000ml)
In-place CBR	CBR Test	To determine CBR value from a field penetration test. CBR is calculated by dividing test load intensity for a given penetration by standard load intensity for the penetration , indicated in percentage. Used to determine paving thickness or bearing capacity of ground	water tank, spoon, inter paper, and stop water Load (truck, etc.), tamaza , screw jack or oil jack, force gauge, penetrating piston, dial gauge dial gauge fixing device, load slab (semi- circular lead plate, 1.25 kg, 4 or more), stand, dry sand

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Table 3-3 (10) Betails of Model Civil Engineering Laboratory Activities

Dotating to finating and isplacement. Then the relationship researe during optime to displacement be assuring device Dotating to finating and isplacement. The assuring device Dotating the assuring device Dotating and isplacement. Dotat		Category	l Category	Purpose of Training and Description	
to determine bearing capacity or coefficient of solid reaction of foundation ground or roadbed/ group and to here is a structure set in a waterway to measure the floating body by varying the center of understand limiting conditions for stability of gravity as well as, the eacher of unoyancy. To understand limiting conditions for stability of the floating body by varying the center of gravity as well as, the eacher of unoyancy. Certification of Notch Weir is a structure set in a waterway to measure aver floating body by varying the center of gravity as well as, the eacher of unoyancy. Certification of Notch Weir is a structure set in a waterway to measure aver float and buoyancy. Certification of Notch Weir is a structure set in a waterway to measure aver float and buoyancy. Certification of Notch Weir is a structure set in a waterway to measure aver float actively a gravity as well as, than a direct. Mannar flow and circle. Mannar flow and the theorem of Bernoulli. Urbulent flow Matter flow in an open channel takes either of Hydraulic pump Understand almar flow sold and the theorem the critical flow. Diidinary Flow, Jet flow in an open channel takes either of the Bernoulli form and transit from acting of the Scharge with a unito measure the critical flow. Discharge from date Dobserve each flow and transit from and transit from acting of the sector with open theretilical flow. Disch				lload and displacement. From the relationship,	
to solution solutions foundation ground or roadhed/ solutions solutions				to determine bearing capacity or coefficient of	
Contribution Subgrtade Subgrtade Rody To measure draft of a floating body and to mederstand labrage of boysancy. Rody To mederstand the relationship between the fractions of stability of the floating body by varying the center of buoyancy. Certification of Notch Wein is a structure set in a wateway to measure of opening. Certification of Notch Wein is a structure set in a wateway to measure of opening. Certification of Notch Wein is a structure set in a wateway to measure of opening. Certification of Notch Wein is a structure set in a wateway to measure of opening. Certification of Notch Wein is a structure set in a wateway to measure the structure stability of the floating contained to the stage of water flow and circle. Certification of Notch Wein the use of venturing to stape of the stage of water flow in an open channel the relatively a stand to understand labrand flow the serious the stand the theorem of structure states of the stand the theorem of structure states of the states of theorem of structure states of the states of theorem of structure states of the states of the states of the states of theorem of structure states of the states of the states of the states of theorem of structure states of the states of theorem of structure states of theorem of states of theorem of structure states of theorem of states of		ی م ب ب ب		soil reaction of foundation ground or roadbed/	
<pre>to Stability of Floating for measure draft of a floating body and to</pre>	-			lsubgrtade	
Body understand the relationship between the Archimedean principle and buoyancy. To fail the floating body by varying the center of understand limiting conditions for stability of the floating body by varying the center of gravity as well as the center of buoyancy. Certification of Notch Weir is a structure set in a wateway to measure atter flow and is classified according to shape of opening, trianguler verteent for relatively a sensure accurate measurement for relatively a sensure accurate measurement. Experiment on Experiment on Didinary Flow Didinary flow and thoreen of buoyancy. Intrbutent Flow Didinary Flow and trianguler vertonen flow and the the trianguler vertonen flow and the the trianguler vertonen flow and the through the septement. Didinary Flow Didinary Flow, and to measure the critical Rewolds number. Didinary Flow Didinary flow and transit from ordinary flow and transit Discharge from Gate To weater flow in the reso f discharge with a unform described the theoretical velues. Discharge from Gate To measure theoretical velues. Discharge from Gate To measure theoretical velues. Discharge from Gate To more theoretical velues. Discharge from Gate To measure theoretical velow such says a coefficient of discharge with a such sector for who and transit from ordinary flow to sector for who and transit from ordinary flow to sector for and sector for a sector with a such sector with presure the section with server the sectimentiation rate of such			ity of	To measure draft of a floating body and to	Floating body (around 30 x 20 x 40cm, with
Archimedean principle and buoyancy. To underastand limiting conditions for stability of the floating body by varying the center of gravity as well as the center of buoyancy. The floating body by varying the center of mater flow and is classified according to shape of opening. triangle, trapecoid, and circle. The triangular weir(notch) used here is designed to essure accurate measurement for relatively a small rate flow and the theorem of Bernoulli through the experiment. To get acquained with the use of venturimeter, and to understand the theorem of Bernoulli through the esperiment. Flow by the Reynolds number, and to understand the theorem of bernoulli three patterns ordinary flow, jet flow, and three patterns ordinary flow, and vice versa. From date the critical Reynolds number. Flow three patterns ordinary flow, and transit from date flow and to measure the critical flow. To observe each flow and transit from date the relatively a size versa. from fate flows normally through a pipe with a uniform diameter, energy loss occurs due to from the provints in the pipe, thereby to verify pressure drop, and to determine the coefficient of friction with a pipe wall. To measure the correction factor for theoretical values of friction loss on the pipe, thereby to verify pressure drop, and to determine the coefficient of friction loss on the pipe wall on particles in a section with the uniform sedimentation rate, and to understand the		Hydraulics	Body	understand the relationship between the	hole), movable weight (300 g iron piece which
<pre>ion of Notch Weiring tonditions for stability of the floating body by varying the center of gravity as well as the center of buoyancy. ion of Notch Weir is a structure set in a waterway to messure water flow and is classified according to shape of opening, triancle, trapezoid, and circle. The trianglar weitwork) used here is designed to ensure accurate measurement for relatively a non To get acquainted with the use of venturimeter, through the experiment. To get acquainted with the use of venturimeter, and to understand the theorem of Bernoulli through the experiment. Flow, Jet Flow and to measurement. Flow, Jet Flow in an open channel takes either of three patterns ordinary flow, and which are distinguished by the Reynolds number, and to measure the critical Reynolds number. from Gate To understand that the rate of dischrige from a critical flow. To observe each flow and transit from Gate To understand that the rate of dischrige from a critical flow. To observe each flow, and critical flow. To observe each flow, and critical flow. To observe each flow and transit the Bernoulli formula, and to measure the coefficient of discharge which serves as a correction factor for theoretical values. oss in Pipe Evan if water flows in the pipe, thereby to verify pressure drop, and to determine the coefficient of friction with a pipe wall. To measure the solimentation rate of suspended at various points in the pipe, thereby to verify of friction vith a pipe wall.</pre>			-	Archimedean principle and buoyancy. To	threaded at the center of circular shape), 1
<pre>ion of Notch Weir is a structure set in a waterway to messure gravity as well as the center of buoyancy. gravity as well as the center of buoyancy. gravity as well as the center of buoyancy. gravity as structure set in a waterway to messure water flow and is classified according to shape of opening, triangle, trapezoid, and circle. The triangular weir(notch) used here is designed to ensure accurate measurement for relatively a small trate flow in the theorem of Bernoulli through the experiment. Flow Jet Flow in an open channel takes either of through the experiment. Flow, Jet Flow Mater flow in an open channel takes either of three patterns ordinary flow, jet flow, and transit from Gate flow in an open channel takes either of three patterns ordinary flow, jet flow, and critical flow. To observe each flow and transit from Gate flow in an open channel takes either of three patterns ordinary flow, jet flow, and critical flow. To observe each flow and transit from Gate flow in an open channel takes either of the Bernoulli formula, and to measure the critical flow flow flow serves as a gree can be theoretically determined by applying the Bernoulli formula, and to measure the correction factor for theoretical values. a various points in the pipe, thereby to verify pressure drop, and to determine the coefficient of friction with a pipe wall. To measure piezo head at various points in the pipe, thereby to verify pressure drop, and to determine the coefficient of friction with a pipe wall. To measure the sedimentation rate, and to understand the</pre>				underastand limiting conditions for stability of	weight (rectangular shaped, smaller than the
<pre>gravity as well as the center of buoyancy. and 300 g each, ruler, balance (sensil ion of Notch Weir is a structure set in a materway to measure Stop watch, steel tape, flow talve, f actual zero, some set in a materway to measure Stop watch, steel tape, flow talve, f actual verinomth used in circle. The point gauge, measuring cylinder, open of opening, triangle, trapezoid, and circle. The point gauge, measuring cylinder, open rianglar weinchenb used here is designed to and to inderstand the theorem of Bernoulli weir, box, sale etc.) differnial the criangle, the cylinder theorem of Bernoulli weir, box, sale etc.) differnial the criangle, the cylinder theorem of Bernoulli weir, box, sale etc.) differnial the through the cylinder theorem of Bernoulli weir, box, scale etc.) differnial the through the cylinder theorem of Bernoulli weir, box, scale etc.) differnial the through the cylinder theorem of Bernoulli weir, box, scale etc.) differnial the through the cylinder theorem of Bernoulli weir, box, scale etc.) differnial the through the cylinder theorem of Bernoulli subber, accessering instrument of the mater the critical Reynolds number. The measuring instrument is and to measure the critical Reynolds number. The measuring instrument is three patterns ordinary flow, jet flow, and critical flow. To beserve each flow and transit from date flow to beserve each flow and transit from date for ordinary flow yiele setter of the Bernoulli formula, and to measure the coefficient of discharge vince a suice gate, poing gage. flow measuring troin gate can be theoretically determined by applying troin date the and the setter of discharge the a correction factor for shore the prevents as a correction factor for shore the prevents as a correction stuth a pipe, thereby to verify pressure drop, and to determine the coefficient of friction of a section with the mail on particles in a section with the weal of friction or with the mail con sedimentation rate of subber the ordificient of friction for a section with the weal of fric</pre>				the floating body by varying the center of	bottom area of the floating body), 100 g; 2
<pre>ion of Motch Weir is a structure set in a waterway to measure according to shape water flow and is classified according to shape water flow and is classified according to shape water flow and is classified according to shape point gauge, measuring cylinder, open triangular weir(moth) used here is designed to easure accurate measurement for relatively a small releficied of the point gauge, measuring cylinder, open and to understand the theorem of Bernoulli rer and to understand the theorem of Bernoulli of get acquinted with the use of venturimeter, Wentrimeter, flow measuring devices and to understand the theorem of Bernoulli rer and to understand the theorem of Bernoulli which are distinguished by the Reynolds number, accessenties, calcuring instrument a which are distinguished by the Reynolds number, accessenties, calcuring instrument i which are distinguished by the Reynolds number. Tow and to measure the critical Reynolds number. which are distinguished by the Reynolds number. which are distinguished by the Reynolds number. Tow and to measure the critical Reynolds number. Weir box caller (21), stop watch, ther and to understand dual the rele of flow, and transit flow deter flow in an open channel takes either of from ordinary flow, beth and transit from date. Flow are distinguished by the Reynolds number. Trom flow are distinguished by the Reynolds number. The properties of the area of flow and transit from fatte flow. In observe each flow and channel flow areastruing instrument in critical flow. To ouderstand that the rate of distor areastruing state. Flow measuring the measuring trom diameter energy los the prevented the conficient of distorare the submethed by the pressure drop, and to determine the coefficient of friction with a prevention the coefficient of friction or act, and to understand the prevention and pressure drop, and to determine the coefficient of friction for a section with the mail con pressure the sedimentation rate of suspended on pressure the sedimentation rate of suspended on pre</pre>				gravity as well as the center of buoyancy.	and 800 g each, ruler, balance (sensitivity
<pre>ion of Notch Weir is a structure set in a waterway to measure stop water fame. How and is classified scornding to shape of opening, triangle, transified scornding to shape of opening, triangle, transified scornding to shape of opening, triangle, transified scornding to shape of opening triangle, transified scornding to shape of the transular wair(notch) used here is designed to transular wair(notch) used here is designed to transified and tricele. The transular wair(notch) used here is designed to and the transular wair(notch) used here is designed to answer accurate measurement for relatively a small rede flow wair for relatively a small rede flow the work stand the theorem of Bernoulli stop watch, the work and to measure the critical Revolds number. Now, scale, etc.), differntial i and to measure the critical Revolds number. Thormaneter and to measure the critical Revolds number. Thormaneter and to measure the critical Revolds number. Thormaneter and to measure the critical Revolds number. Thermoneter and to measure the critical Revolds number. Thermoneter and to measure the critical Revolds number. Thermoneter and the watch are all discharge from a study down to general from three patterns ordinare list stop watch are allowed as the stop and thermoneter areas step with the sport and thermoneter areas step with the sport stop watch. Thermoneter from diameter for theoretical variance was and the second variance watch a stand to measure the critical Revolds number. Thermoneter form the sport and theoretical variance bound the stop of discharge the variance bound the stop of discharge the variance bound the stop of discharge the stop addition and theoretical variance bound there are and to measure the critical Revolds and theoretical variance bound the stop of stop addition arese and to measure the crit</pre>			-		around 1 g), bolt (65-70 cm lond and 0.9 mm
<pre>ion of Notch Weir is a structure set in a waterway to measure Stop watch, steel tape, flow vate, fl water flow and is classified according to support according cylinder, open of opening, triangle, trapezio, and circle. The trianglar weire flow and is classified according to the perine accurate measurement for relatively a small rate flow ensure accurate measurement for relatively a small rate flow not no for set acquainted with the use of venturimeter. Wenturimeter, flow measuring devices in through understand the theorem of Bernoulli stop, watch, bernement for relatively a small rate flow flow and to measure the critical Reynolds number. Nenturimeter, flow measuring instrument for which are distinguished by the Reynolds number, accossible, calcuning instrument for which are distinguished by the Reynolds number, accossible, calcuning instrument for which are distinguished by the Reynolds number. Reynolds number measuring instrument for which are distinguished by the Reynolds number. Reynolds number accossible, calcuning instrument for which are distinguished by the Reynolds number. Reynolds number measuring instrument for which are distinguished by the Reynolds number. Reynolds number flow measuring instrument for which are distinguished by the Reynolds number. Reynolds number accounting instrument for which are distinguished by the Reynolds number. Reynolds number measuring istrument for here pattern flow in an open channel takes either of 2 point gauge. Stee. Ispe, stop watch, measuring three pattern flow. To boserve each flow and trannsit from fate flow nuderstand that the rate of discharge frow and the Resource of discharge flow, and configued flow is a super point gage. flow measuring istrument, stop watch, measuring the Resource of discharge take with P pipe for experiment, stop watch, measuring the support of discharge flow is stored applying the support of discharge is the pipe, thereby to verify pressure drop. and to determine the coefficient of the flow istore the sedimentation rate, and to under</pre>					water tank (60 x 50x 80 cm), plumb, thermom
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28 S & S			Experiment on		
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<pre>the orfice can be determined theoretically by watch, applying the Bernoulli formula, and to measure the coefficient of discharge which is a correction factor for theoretical values. a correction factor for theoretical values. a correction factor for theoretical values. a pipe and to understand that distribution of compare understand that distribution of a pipe and flow rate measures agree with theoretical values. before and flow rate measures agree with theoretical values. before and flow rate measures agree with theoretical values. before and flow rate measures agree with theory to varier flowing in a pipe, energy loss occurs Stop y theory to value flowing in a pipe, and of the pipe. To measure the pisco head before and after a pipe with section and verify energy loss in water flow due to theory to verify energy loss in water flow due to ment of Current To measure the pisco and to draw measu annel ment of Current To measure current speed distribution annel curves. To calculate the average current speed introbution in uniform and vertical current speed distribution annel uniform and vertical current speed distribution manome curves. To calculate the average current speed distribution annel flow water determine the flow rate. Then to curves. To calculate the average current speed distribution and to draw a divided into uniform flow where doen claanel flow is divided into uniform flow where doefficient are determined. As an example of nonniform water determined. As an example of nonniform flow, water determined. As an example of nonniform flow water determined. As an example of nonniform flow is a to the oretical backfrate curves. Deations. Then to measure water surface pattern backer and condinge the result to theoretical backfrate curves. Deations in jakes and seas. Deations water determined as an example of avere avections in aveclength through basic tape. Deations water determined as and to understand wave meations in aveclength through basic tape. Deations in aveclength such aveclength and current sea b</pre>		8	To understand that the discharge rate at	Orijice for experiment, measuring cylinder, stop
<pre>applying the before the of discharge with is a correction factor for theoretical values. ution of Current a poise and to understand that distribution of inner correction factor for theoretical values. correction factor for theoretical values. correction factor for theoretical values. correction factor for theoretical values. correction factor tate measures agree with calle thooretical values. Loss due to Rapid For water flowing in a pipe, energy loss occurs Stop y in Fipe Diameter due to change in sectional area of the pipe. To measure the piezo head before and after a pipe which section rapidly increases or decreases. therby to varity energy loss in water flow due to repid change in sectional area. To measure current speed distribution annel uniform and vertical current speed distribution annel curves. To calculate the average current speed distribution in uniform and vertical to theoretical values. ben Channel work and current speed distribution doen Compare the results to theoretical values. doen Channel flow, water determine the flow where don Uniform Morthal flow a were set on the measure and to draw measure doen change. Then to determine the flow rate. Then to compare the results to theoretical values. doen Channel water determine the result or theoretical. water depth and current speed does not change for nuniform flow, water determined. As an example of nuniform flow, a were is set at the domarream end to observe changes in flow between differnt locations. Then to measure determined. As an example of and to observe changes in flow between differnt battern and conders and sourt suctions. table and to understand water depth, and averlength through basic table batters on yes motions and to understand water depth, and water determined. As up the ordiod, water doen to share and sourt and to understand water depth, and water determined to understand water depth, and water determined to understand water depth, and water determined to understand water depth, and wav</pre>			the orifice can be determined theoretically by	watch, vernier calipers, and flow metering value
<pre>ution of Current Creat of a distribution of correction factor for theoretical values. ution of Current To measure current speed at various points in Pipe, a pipe and to understand that distribution of copper every and the and the speed at various points in Pipe, to represent and the ansures agree with a measu sexponential rule. Also to check that current differ speed and flow rate measures agree with measu theoretical values. Loss due to Rapid For water flowing in a pipe, and before and fiter a pipe which section rapidly increases or decreases, theoretical values. Loss due to Rapid For water flowing in a pipe, and before and differ a pipe which section rapidly increases or decreases, therby to varity energy loss in water flow due to therby to varity energy loss in water flow due to rapid change in sectional area. To measure the pizzo head before and to draw measu istribution in understand how they are distributed, and to draw measu annel understand how they are distributed, and to draw measu uniform and vertical current speed distribution manom of the corress section from measured current speed of nuler speeds, and to determine the flow rate. Then to bend of Channel value flow, a weir is set at the downstream from place the results to theoretical values. Domuniform flow, a weir is set at the downstream end to observe changes in flow between differnt locations. Then to measure water surface pattern and compare the result to theoretical - betweet enviros. Then to measure water surface at a downstream end to observe changes in flow between differnt betweet we between and compare the result to understand water depth, and averlength through basic dominiform water depth, and averlength through basic attern and compare the result to understand water depth, and averlength through basic dominiform water depth, and surface and to understand water depth, and averlength through basic attern and compare the result to understand water depth, and averlength through basic attern and compare the result through basic attern</pre>			applying the bernoulli lormula, and to measure	
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Table 3-3 (11) Details of Model Civil Engineering Laboratory Activities

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3-3 (12) Details of Model Civil Engineering La Purpose of Training and Description distribution and average flow rate for the section. This is very important for river improvement and maintenance, and flow control measures.	
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Surveying Practice				- -							
1) Disatnace Surveying	*	*	*	*	*	*	*	*	*	*	*
2) Precise Distance Surveying		*									
3) Angular Measurement	*	*	*	*	*	*	*	*	*	*	*
4) Traverse Surveying	*	*	*	*	*	*	*	*	×	*	*
5) Offset Measurement	*	*	*	*	*	*	*	*	*	*	*
6) Plane Table Surveying			*			 					
7) Levelling	*	*	*	*	*	*	*	*	¥	*	*
8) Studio Surveying		*									
9) Triangular Surveying		*				 					
10) Photogrammetry		*									
		•									
Experimental Methods in Soil Mechanics						 					
1) Moisture Content Test	*	*	*	*	*	*	*	*	*	*	*
2) Unit Feight Test of Soil	×	*	*	×	*	*	*	*	*	*	*
3) Specific Gravity Test of Soil Particle	*	*	*	*	*	*	*	*	*	*	*
4) Liquid Limit Test	*	*	*		*	*	*	*	*	*	*
5) Plastic Limit test	*	*	*		*	*	*	*	*	*	*
6) Grain Size analysis	*	*	*	*	*	*	*	*	*	*	*
7) Permiability Test	*	*	*		*		*	*		*	*
8) Consolidation Test	*	*	*	*	*		*	*	*	*	
<pre>9) Direct Shear test</pre>	*	*	*	*	*		*	*		*	
10) Unconfined Compression test	*	*	*	*	*		* *	*	 	*	*
11) Triaxial Compression Test	*	*						*			*
12) Compaction Test	1 . 1 . 1 .	*		:	*					*	
13) Laboratory CBR Test		*			*		*	*	*	*	
		*					•			*	
15) Static Cone Penetration Test		*		*	*		*	*	*		*
16) Field Vane Test										1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
17) Field CBR Test	_										
18) Plate Bearing test											
19) Field Permisbility Test					•						
20) Field Unit Weigth Test of Soil											
21) Boring, Drilling											
22) Thin Wall Tube Sampling		*		 							 i
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Table 3-4 (1) Actual Activities in Civil Engineeirng Laboratories

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Laboratory Practice / University	EAIYZNU	USU NOMMENSEN	NN UMA	NDA	0150	UNAND	UNSRI U	UNILA UNTAN	N UNLAN
1) Test for Specific Gravity of Cement	*	*	*		*	*			
2) Test for Fineness of Cement	*	*	*		*	*			
3) Test for Setting Timen of Cement	*	*	*		*	*		-	
4) Test for Soundness of Cement	*	*	*		*	¥			1
5) Test for Strength of Cement	*	*	*		*	*		5 : 	
6) Test for Sieve Apalysis	*	*	*	 	*	*		*	*
7) Test for Specific Gravity and Absoption	*	*						*	*
of Fine Aggregate				:	-				
8) Test for Specific Gravity and Absorption of Concessions	*	*	:					*	*
9) Post for Unit Wight and Solid Volume Percentage		*	*		- - - - - - -			*	*
Test for Surface Moisturer		*							
	*	*	*	*	*	*	-	*	*
12) Test for Air Content in Presh Concrete	*	*	*		*				
13) Test for Compressive Strength of Concrete	*	¥	*	*	*	*			
14) Test for Splitting Tensile Strength of Concrete	*	*			*				
15) test for Flexural Strength of Concrete	*	*			*			*	*
16) Besign for Mix Preportion	*	*	*	*	. * .	*		*	*
17) Test for Abrasion of Coarsed Aggregate				*					
÷									
IV. Experimental methods in Hydraulics							 		
1) Stability of Floating Body				:					
2) Calibration of V-notch Weir	*								
3) Experiment on Venturimeter	*								
4) Laminar Flow and turbulant Flow	*							 	
5) Subcritical flow Supercritical Flow	*								
7) Friction Loss of Pipe Flow	*					-			
8) Sedimentation of Particle			-						
9) Experiment on Orifice	*								
10) Elocity Distribution of Pipe Flow									
11) Energy Loss Due to Sudden Contraction	*								
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12) Velocity Distribution of Open Channel Flow								*	
13) Uniform and Nonuniform Flwow of Open Chnnel								*	*

Laboratories
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3-4 (3)
Table

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Table 3-5 (1) Details of Model Mechanical Engineering Laboratory Activities

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гаца жасцица Уланатата	-4		UTILICE-WELEY, MANUMETER WALEFFLAINA, MELSUNING
Tuantjadya	dellvery rate	OTILICE-meter and learn now to measure the iluld	machine, large pucket, stop-watch, thermometer,
		delivery rate. and induce a experimenal equation	scale. slide calibers. manometers. a set of pipe
		through the eventients	
	Meesseet of Decourse	<u>111 UGSU VIC SAPEL HUGULS.</u>	ALLOS
	ainssail in themains and	orndents submid measure für bressnie foss in fue	addinguent for measurement of pressure loss in the
	TOSS IN a PIDE	straight pipe or the head loss due to deflection	pipe, manometer, water-tank,
		of the pipe, and understand the meaning of the	weighing machine, large bucket, stop-watch,
		head loss, when a fluid flows in a pipe.	thermometer, a set of tools for setting pipe,
			polithmant for measurement of athous loss of
	Performance test of	Students should overate a pump and examine its	Pump. a set of water channel. 3 phases induction
	onno		motor triangular notch weir, hook gauge.
			nrocentro gauge Varunn gauge Volt meter Ammeter
			without the server is a server with a server of the server with the server is a server the server serve server serve server serv
-	Performance test of	Theoritical power, net power and comparative	Francis hydrauric turbine, water supply pump,
	Francis turbine	rotating speed have to be measured. Students	equipment for measurement of fluid delivery rate,
			dynamo matar vaishing machina tachomatar
	Performance test of air	Students should operate multi blade fan and	Experimental set of multi blade fan, manometer.
			inclimation manometer pitot pipe, tachometer.
		uhan air ranarity ic chanced They chuid learn	nevehromator necessro saugo volt motor
		Much all capacity is changed. Include to in bou to champio (that will' the de for	ydysuussiaate, yreodale gaadaa, ou o wolon ammatar satt matar
	Small evnerimental	HUM IN OPERATE AND MULLI PLANE IAN. Posistance and disturbance of air flow	ammetet, nace meret. A cat of eventmental wind turne) manometer
	trind turnel		
			- 11- 4010 1 - 11- 04 - 466466 - 10-01-10-01-10-10-10-10-10-10-10-10-10-1
Performance test of	Costant rotating speed	1-0	Water cooled constant speed internal compustion
internal comburstion			engine. Junkers water-dynamo meter, weighing
engine		constant rotating speed. And they should examine	
\$		the performance of the engine under each	
		condition of full, over, and partial load.	thermometer pressure gauge, psychrometer.
			density meter, tools for a usting engine, thermo
		· · · · · · · · · · · · · · · · · · ·	couple
-	Constant load	Students should learn the opration of internal	Water cooled internal combustion engine electric
			dynamometer, techometer, milivolt meter for
		variable speeds such as automobile engine, and	thermocuple, tools for ajusting engine
			thremometer. pressure gauge, equipent for
		each condition of full and partial load when	adjusting engine. thermometer, pressure gauge
			equipment for measurement of fuel consumption,
			density meter, stop-watch, vacuum meter,
			D.C. volt meter, D.C. ammeter, sliding type
Electical experiment	5	applying Students should measure the resistance by fall-of	measure the resistance by fail-of resistor, buttery, resistance, switch
	Cha's law and	potential method. After understanding	
	kirchhoff's law or RLC	kirchhoff's law, they should compare measuring	
	circuit experiment	valves with calculated valves in a complex	
		Altrault compared hy mand than the altrand elimented	

Ministration of the section of the sectin of the section of the section of the section of the s		Experimental subject	Purpose and contents of experiment	Main experimental equipment
resistance by using wheetistone bridge and measure various kinds of resistance by using it. Special Characteristic Students should measure each valve of the rest of 3 phase induction motor induction motor characteristics of 3 phases induction method they should understand the load characteristic and the speed characteristic etc. of 3 phases induction motor. Characteristic etc. of 3 phases induction of the stateristic etc. of 3 phases induction of the stateristi		Measurement of a		wheatstone bridge, galvanometer, sliding type
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for measuring hardness. le and compressive Student should examine the mechanical properties Universal tensile machine, of materials such as tensile strength, yield micrometer, side calipers, point, elongation and shear strength and learn hammer, specimen, paper for how to operate a testing machine. Also, they load cell should learn how to make the specimen. Students should understant that this is important universal tensile machine, in industry to know the strength and the portant universal tensile pin, workahility of metal		vickers hardeness	bardness tester and learn how to make specimens	various metal specimen cutting specimen machine,
<pre>le and compressive Student should examine the mechanical properties Universal tensile machine, of materials such as tensile strength, yield micrometer, side calipers, point, elongation and shear strength and learn hammer, specimen, paper for how to operate a testing machine. Also, they load cell should learn how to make the specimen. Students should understant that this is important universal tensile machine, in industry to know the strength and the for automative record load workability of metal.</pre>			for measuring hardness.	a set of polishing machine
of materials such as tensile strength, yield micrometer, side calipers, point, elongation and shear strength and learn hammer, specimen, paper for how to operate a testing machine. Also, they load cell should learn how to make the specimen. Students should understant that this is important universal tensile machine, in industry to know the strength and the calipers, marking-off pin, workahility of metal.		P	Student should examine the mechanical properties	Universal tensile machine, V block (chuck),
point, elongation and shear strength and learnhammer, specimen, paper forhow to operate a testing machine. Also, theyload cellshould learn how to make the specimen.and cellshould learn how to make the specimen.callers a testing machine,in industry to know the strength and thecalleers, marking-off pin,workability of metal.for automative record load			of materials such as tensile strength, yield	micrometer, side calipers, marking-off pin,
how to operate a testing machine. Also, they load cell should learn how to make the specimen. Inversal tensile machine, test Students should understant that this is important universal tensile machine, in industry to know the strength and the calipers, marking off pin, workability of metal.			point, elongation and shear strength and learn	hanner, specimen, paper for automatic record,
should learn how to make the specimen. test Students should understant that this is important universal tensile machine, in industry to know the strength and the calipers, marking off pin, workability of metal.			how to operate a testing machine. Also, they	load cell
test Students should understant that this is important universal tensile machine, in Industry to know the strength and the calibers, marking-off pin, workability of metal			should learn how to make the specimen	
			Students should understant that this is important	V block (chuck),
for automative record load			in industry to know the strength and the	
	-		workability of metal.	1080

Table 3-5 (2) Details of Model Mechanical Engineering Laboratory Activities

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Details of	
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Table 3-	

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equipment	Chalpy impact testing machine, gauge, side	calipers, micrometer, specimen, temperature	imen for ceps.	microscope for metals, photographic equipment for	microscope, specimen, polishing machine, powder			small rolling machine, small foreging machine	side calipers micro meter, small furnace (800 °C) specimen forcoss.	lathe, milling machine, drilling machine, chopper	machine, sawing machine, grinder, a set of tools.		, block gauge,	for volatile oil, benzine, gasoline, gauge, washing			tool maker's microscope, parallel make screw etc.			drawing instrument, machine elements model.	•	D.C. are welding machine, cord reel, volt meter,	ammeter transformer, stainless steel sheet, pipe,	eye glass, hammer, acid washing bath, welding	pment for examining		eter, ammeter,	transformer, specimen sheet, equipments for examining the structure of welding part.
Main experimental equipment	testing machin	cometer, specim	(low temperature) rack, specimen for ceps.	r metals, photo	becimen, polish	for polishing, etching egent		machine, small	micro meter, s Nos.	r machine, dril	ig machine, gri		micrometer, micrometer stand, block gauge	benzine, gasol	•		nicroscopé, par			ment, machine	-	ing machine, co	Cormer, stainle	nner, acid wash	electrode; drying oven, equipment for	ırt.	spot welding machine, volt meter, ammeter	transformer, specimen sheet, equipments examining the structure of welding part
l Mair	Chalpy impact	calipers, micr	(low temperate	microscope for	microscope, si	for polishing		small rolling	side calipers mi specimen forcoos	lathe, milling	machine, savit	· · · · ·	micrometer, m	<pre>c] volatile oil,</pre>	bath				 	drawing instru		D.C. are weld	ammeter transf	eye glass, han	electrode, dry	the welding part	spot welding n	transformer, seven the
experiment	principle of	t of	mild steel.	cture and the	is and photo-	bu to make the		schniques of	for metals such as rolling and foreging.	o operate machine			ortation of the	spection method fo	by using block	They should learn how to use block gauge	should understand the principal and the	structure of tool maker's microscope and measure	srallel make screw	ength of machine		ld sheet and pipe	s steel and observe in the welding part.		-		lique for spot	-
Purpose and contents of experiment	should understand the principle of	impact test, and do the meaning of	ductaile-brittle transition of mild steel.	should learn the structure and the	of microscope for metals and photo-	equipment. and learn how to make the		should practice the techniques of	etals such as rol.	should practice how to operate machine		 	should learn the calibriation of the	micrometer and the inspection method	accuracy of micrometer by using block	should learn how	ld understand the	tool maker's micro	a pitch and a effective of a parallel	and calculation of strength of machine	should be studied.	should practice to weld sheet and pipe	el and observe in				should learn the technique for spot	of metal sheet and wire.
Purpos	Students shou	impact test,	ductaile-brit			graphic equip	specimens.	Students shou	working for m	Students shou	tools.	. 			knowing accur		Students shou	structure of	a pitch and a	Drawing and c	elements shou	Studnets shou	stainless ste					welding of me
Experimental subject	Chalpy impact test			Ebservation of	micro-structure of metal funtion			Experiment of working	for metals	Machine total experiment Operation of lathe,	milling machine and	drilling machine etc.	Calibration of	micrometer by using	block gauge		Measurment of Pitch of	screw by tool maker's	aicroscope	Hachine elements,	basic design	Practice of welding of	stainless steel				Practice of spot welding Students	of various metals
				-						total experiment						<u></u>						Practice		-				
		-						-		Machine		: : : : :	Measurment		;					Machine elements	design	Welding Practice						

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Course	UNSYIAH	USU	UHA	UDA	UISU	IOUVUD	ายแอนา	nunnungen
I. Fluid machinery experiment			·	-	*	*		*
(1) Heasurement of fluid delivery rate		*	*					*
(2) Heasurement of yearing loss		*	*		*	*		
(3) Pump performance	*	*	*	*	*	*	*	*
(4) Turbine perofrmance		*	*	*		_	*	*
(5) Air blower performance		*						
(6) Small wind tunnel experiment		*	*			<u> </u>		*
(7) Compressor performance	*				· - ·		*	*
II. Internal combustion engine								
	*	· · · · · · · · · · · · · · · · · · ·	*	+			*	
(1) Decomposition and composition	·			+		*		
(2) Haterial examination of engine		*	*				*	*
(3) Engine performance	-}				- <u> </u>	+		
- Constant speed of rotation						+	*	
(4) Engine performance		* .	*					
- Constant load								*
(5) Gas turbine performance	1	L.,						-
III. Drawing, Hachine elements	-{		-{			1		
(1) Design & Drawing	*	*	*	*	+	*	*	*
(2) Machine elements	*	*	*	*	*	1 *	*	*
IV. Material experiment			<u></u>		. <u> </u>	<u> </u>		
(1) Tensile and compression test	*	*	*		*	*	ļ	*
(2) Bending test	¥	*	*	*	*			*
(3) Buckling test	*	* .				*		
(4) Hardness measurement	*		*	*	*	*		
(5) Casting experiment		· · · · ·				1		1: .
(a) Sand mould maching	-{				-	1	1 .	1
(b) Helting, Casting				·	-1		1	
(6) Examination of micro-structure	1	*	*	*	*	+		
(7) Examination of ductile-brittle	+ · · · ·	*	*			*	1	
transition (Chaply impact test)	1 1		{ .				.	1
(8) Corrosion test			· · · · · ·		1	*	<u> </u>	
				1	+		·	+
V. Thermodynamics experiment					-	+	····	
(1) Calorimetry			-	÷	-{	*	†	* .
VI. Neat transfer and refrigeration			·	<u> </u>				
air conditioning experiment				<u>'`</u>			<u> </u>	·
(1) Adiabatic sahirator experiment	.)	*		*		*		
(2) Refrigerator performance				*		*	*	
VII. Welding Practice			<u> </u>		·	<u>} .</u>	<u> </u>	
(1) Wolding of stainless steel				<u> </u>		<u> </u>	·	-{
	<u> </u>	 	-l		<u></u>	·	*	
(2) Acetylene gas welding	*			·		_		¥
(3) Spot welding	*	*	+		*		*	*
VIII.Welding practice	┨╼╍╼╼┥		· [
(1) Calibration test of micrometer	*	*	*	·/	*	+	<u> </u>	+
(2) Tool maker's microscope test	<u> </u>	·		+		· [· · · · · · · · · · · · · · · · · · ·	
(3) Heasurement of vibration	*						<u> </u>	
······································	+		+		- 		<u> </u>	+
XI. Practice of machine tool	· · · ·				1		· · · · · ·	
(1) Practice of lathe	*	*	*	*	*	+	*	*
(2) Practice of drilling machine and shaper	*	*	1	*		*	*	*
(3) Practice of filing and polishing	+	*	*	*		·	ļ	
	· • 1		. ×		*	i *	*	*

Table 3-6 Actural Activities in Mechanicla Engineering Laboratories

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Table 3-7 (1) Details of Model Electrical Engineering Laboratory

ITEM	PURPOSE	MAJOR EQUIPMENT
1. ELECTRICITY		99 m
1.1 Voltmeter	use of voltmeter	A.C.voltmeters, D.C.voltmeters, batteries, switches, standard variabl resistor, lamps
1.2 Ammeter	use of ammeter	D.C.ammeters, A.C.Ammeters fixed resistors, shunt, batteries, loads, switches
1.3 Resistor	use of various resistors	D.C.voltmeter, D.C.milliammeter, fixed resistor, batteries, switches, various kinds of resistors
1.4 Circuit Tester	measurement of D.C.voltage, D.C.current, A.C.voltage, resistance etc. using a circuit tester	circuit testers, batteries slidac, various kinds of resistors, diodes, electrolytic capacitor
1.5 Ohm's Law		D.C.milliammeter, D.C.voltmeter, slide reostat, D.C.power source, switches, fixed and variable resistors
1.6 Kirchhoff's Law		D.C.ammeters, rheostats, batteries, switches, circuit tester
1.7 Characteristics test of a dry cell	measurement of the inter- nal resistance and the characteristics of dry cell	D.C.voltmeter, load resistor, dry cell, switches, stopwatch
1.8 Pointer type galvanometer	measurement of the sensi- tivity of a pointer type galvanometer	galvanometer, D.C.voltmeter, high resistor, battery, variable resistor, switches, stopwatch
1.9 Measurement of resistance by the drop method	measurement of resistance using a galvanometer and ammeter	D.C.power source, D.C.voltmeter, D.C.ammeter slide rheostat, switches, resistors
1.10 Measurement of resistance by the drop method	measurement of resistance using a galvanometer and a known resistance	pointer type galvanometer, slide rheostats, universal shunt, battery, switches
1.11 Measurement of resistance by the equal defle ction method	measurement of the resistance of a galvanometer	galvanometer, slide rheostat, standard resistors, battery, switches
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	Table 3-7 (2) el Electrical Engineering	Laboratory
Details of Moo	el Flecticar puRrugerug	DEPORTOON

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ITEM	PURPOSE	MAJOR EQUIPMENT
1.12 Measurement of resistance by the Wheatstone bridge		PO box, galvanometer, universal shunt, battery, multimeter, fixed resistors, low frequency choking coil
1.13 Measurement of the resistance of a galvano- meter by the Kelvin method	measurement of the resistance of a galvanometer using a Wheatshone bridge	galvanometer, slide rheostats, batteries, switches, Wheatstone bridge
1.14 Measurement of resistance using the Kelvin double bridge	measurement of resistivity by the Kelvin double bridge method	D.C.ammeter, rheostat, battery, switches, Kelvin double bridge, micrometer
1.15 Measurment of the resistance of electrolyte by the Khol- rausch bridge		Kohlrausch's bridge, U type tube, water tank, thermometer, electric heater, electrolyte
1.16 Measurement of earthing resis- tance by the Kholrausch bridge		earthplate, auxiliary earthpole, Kohlrausch bridge
1.17 Measurement of insulation resistance by the megger	measurement of the insula- tion resistance of electric equipment and interior wiring	megger, transformer, interior wiring
1.18 Measurement of insulation resistance by the mirror galvanometer	measurement of the resis- tance of insultated wire by the direct deflection method	mirror galvanometer, D.C.voltmeter, D.C.power source, rheostat, universal shunt, insultated wire, switches
1.19 Measurement of the constants of the ballistic galvanometer		ballistic galvanometer, rheostat, mutual inductance, D.C.milliammeter, slide rheostat, switches, battery, stopwatch
1.20 Calibration of D.C.meters		standard D.C. meters, D.C.voltmeters and ammeters to be calibrated, shunt, rhostat, switches, D.C.power source
1.21 Measurement of the electro- motive force of a battery using the potentiometer		battery, standard cell, power supply battery, pointer type galvanometer, shunt, resistor to adjust the supply voltage, resistor to protect the standard cell, D.C.ammeter, switches, D.C.potentiometer, volt box

Table 3-7 (3) Details of Model Electrical Engineering Laboratory

	ITEM	PURPOSE	MAJOR EQUIPMENT
1.22	Calibration of an ammeter and a voltmeter using the potentio- meter		ammeter, voltmeter, D.C.power supply, standard cell, D.C.ammeter, pointer type galvanometer, standard resistor, rheostat, shunt, D.C.potentiometer, volt box switches
	Measurement of the characte- ristics of the thermocouple	measurement of the thermo-electromotive force of a	thermocupple, slidac, electric furnace, thermo- stat, switches, D.C.millivoltmeter, thermometer, watches
1.24	Measurement of the charge- discharge chara- cteristics of the storage battery	measurement of the charge and discharge characteristics of a lead storage battery	storage battery, D.C.voltmeter, D.C.ammeter, rheostat, densitometer, switches, thermometer
1.25	Measurement of electrochemical equivalent using the voltmeter		voltmeter, D.C.ammeter, storage battery, rheostat, switches, sulfuric acid, alchol, chemical balance, copper sulfate, beaker
1.26	Measurement of capacitance and inductance using an A.C.bridge	Principle of the A.C. bridge and measurement of L and C	inductance, capacitor, variable standard inductance, variable standard capacitor, low frequency oscillator, receiver, keys, A.C.bridge
1.27	Use of the Oscilloscope	observation of A.C.wave forms	oscilloscope, slidac, signal generator, circuit tester, vacuum tube voltmeter, circuit to operate an oscilloscope
1.28	Measurement of L and C by the potential drop method	measurement of L and C by the potential drop method. characteristics of iron- core inductance	iron-core inductance, air- core coil, capacitor, standard rheostat, A.C.voltmeter, A.C.ammeter, slidac, switches
1.29	Measurement of one-phase electric power	measurement of one-phase electric power by three methods; one-phase wattmeter method, three ammeters method, three voltmeters method	one-phase wattmeter, A.C.ammeters, A.C.voltmeters, standard, rheostat, variable reactor, lamp, switches
1.30	Measurement of three-phase electric power	measurement of three-phase electric power by the two wattmeters method	one-phase wattmeter, three-phase wattmeter, A.C.ammeter, A.C.voltmeters, switches, balanced three-phase load, induction voltage regulator

	Table 3-7	(4)	
Details of Model	Electrical	Engineering	Laboratory

	ITEM	PURPOSE	MAJOR EQUIPMENT
1.31	Characteristic measurement of the integrating wattmeter		one-phase integrating wattmeter, one-phase wattmeter, A.C.voltmeter, A.C.ammeter, load resistor, variable reactor, slidac, switches, stopwatch
1.32	Hysteresis loop	measurement of the magnetic hysteresis of a ring type iron-core using a flux meter	flux meter, D.C. ammeter, A.C.ammeter slidac, switches, slide rheostat, storage battery, iron cores
1.33	Measurement of iron loss by the Epstein appratus	measurement of iron loss using the epstein apparatus and the magnetization curve of magnetic materials	A.C.voltmeters, A.C.ammeter, wattmeter, frequency meter, mutual inductance, slidac, switches, Epstein apparatus, seight scale, magnetic materials
1.34	Efficiency test of an electric heater		beaker, thermometer, A.C.ammeter, A.C. voltmeter, slidac, switches, wattmeter, integrating wattmeter, electric heater
1.35	Measurement of the characteri- stics of fuse	relation between fusing current and fusing time	A.C.ammeter, cycle counter, rheostat, lamp, switches, micrometer, balance, stopwatch, fuses
1.36	Observation of wave forms by the electro- magnetic oscillograph		battery, D.C.milliammeter, rheostat, switches, electromagnetic oscillograph, slidac, A.C.voltmeter, A.C.ammeter, iron-core inductance
1.37	Measurement of the four termi- nal network constant		for the D.C.circuit-battery, D.C.voltmeters, D.C. ammeters, resistors in the four terminal network, switches for the A.C.circuit-slidac, A.C.voltmeters, A.C. ammeters, switches, transformer, fixed resistors, dual trace oscilloscope
2. E	LECTRIC MACHINES	J	
2.1	Measurement of a turn ratio of a one-phase transformer and its polari- ty test		one-phase transformers, A.C.voltmeters, fuse holder, knife switches

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Table 3-7 (5) Details of Model Electrical Engineering Laboratory

ITEM	PURPOSE	MAJOR EQUIPMENT
2.2 No load test of a one phase transformer	no-load loss of a transformer. measurement of exciting current. calculation of excitation admittance	one-phase transformer, one- phase induction voltage regulator, one-phase wattmeter, rheostat, A.C. voltmeter, A.C.ammeter, D.C.voltmeter, D.C.ammeter, knife switch
2.3 Short circuit test of a one- phase trans- former	measurement of the load loss and the impedance voltage of a transformer. calculation of the percent impedance. Voltage regulation and conventional efficiency	one-phase transformer, one- phase induction voltage regulator, one-phase wattmeter, A.C.ammeter, A.C.voltmeter, knifeswitch, thermometer
2.4 Load test of a one-phase transformer	measurement of the input power and output power with load. measurement of the voltage regulation and efficiency	one-phase transformers, one- phase wattmeter, A.C.votmeter, A.C.ammeter, induction voltage regulator one-phase load apparatus
2.5 Three-phase connection of one-phase trans- former	various methods of three- phase connection. relation of the phase voltage and the line voltage	one-phase transformers, voltage regulators, A.C.voltmeters, A.C.ammeters, one-phase wattmeters, megger, D.C.voltmeter, D.C.ammeter, thermometer
2.6 Temperature rise test of a trans- former by the loading back method		one-phase transformers, voltage regulators, A.C.voltmeters, A.C.ammeters, one-phase wattmeters, megger, D.C.voltmeter, D.C.ammeter, thermometer
2.7 Other connections of transformers	six-phase connection. T-connection. Relation of the phase voltage and the line voltage	one-phase transformers, A.C.voltmeter, load apparatus, electromagnetic oscillograph
2.8 Starting test of a three-phase induction motor	starting characteristics of a three-phase induction motor	cage-type induction motors, wourd-rotor induction motor, synchroscope, starting compensator, Y- delta switch, resistors, A.C.voltmeters, A.C.ammeters, shunt
2.9 Drawing of a circle diagram of the three- phase induction motor	drawing method of circle diagram. measurement and computation of the characteristics to draw a circle diagram	three-phase induction motor, one-phase wattmeters, A.C.voltmeter, A.C.ammeter, frequency meter, three-phase induction voltage regulator D.C.ammeter, D.C.voltmeter, resistor, thermometers
J	3 -63	

Table 3-7 (6) Details of Model Electrical Engineering Laboratory	

	ITEM	PURPOSE	MAJOR EQUIPMENT
2.10	Load test of the three-phase induction motor using the elect- ric dynamometer		three-phase induction motor electric dynamometer, three phase induction voltage regulator, A.C.voltmeter, A.C.ammeter, three-phase wattmeter, D.C.ammeter, tachometer
2.11	Characteristics test of a one- phase induction voltage regu- lator	no-load and short-circuit test of a one-phase induction voltage regulator	one-phase induction voltage regulators, one-phase wattmeters, A.C.voltmeters, A.C.ammeters, frequency meter
2.12	Starting test of a D.C.moter	starting cahracteristics, construction features of a starting apparatus	D.C.shunt motor, starter, field regulator, tachometer, D.C. ammeters, D.C.voltmeter, synchroscope
2.13	Speed control of a D.C.motor	advantages and disadvan- tage of various speed control methods	D.C.motor, D.C.generator, three-phase induction motor starter, field regulator, armature series resistor, D.C.voltmeters, D.C.ammeters, A.C.ammeter. A.C.voltmeter, tachometer
2.14	Load characte- ristics test of a D.C.motor	vertification of torque and efficiency by rotation speed	D.C.motor-generator, starter, field regulators, tachometer, D.C.voltmeters, D.C.ammeters load resistor
2.15	No-load chara- cteristics test of a D.C.gene- rator	relation of the current and the induced electro- motive force in D.C.gen- erator. relation between rotation speed and induced electromotive force	D.C. motor-generator, starter, field regulators, tachometer, D.C.voltmeter, D.C.ammeter
2.16	Load characte- ristics of a D.C.generator	measurement of the terminal voltages vs the load currents	D.C.motor-generator, field regulators, starter, D.C.voltmeters, D.C. ammeters, tachometer, load resistors
2.17	No-load test of a three- phase synch- ronous gene- rator	no-load and short-circuit test of a three-phase synchronous generator. synchronous impedance. short-circuit ratio. voltage regulation	D.C.three-phase synchronous motor-generator, field regulators, starter, D.C. voltmeters, D.C.ammeters, A.C.voltmeter, A.C. ammeters, frequency, meter, tachometer
2.18	Load test of a three-phase synchronous generator	load test. calculation of the efficiency and voltage regulation	D.C.three-phase synchronous motor-generator, field regulators, starter, three- phase load apparatus, D.C. voltmeters, D.C.ammeters, A.C.voltmeter, A.C.ammeter, three-phase wattmeter, three-phase power-factor meter, frequency meter

Table 3-7 (7) Details of Model Electrical Engineering Laboratory

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	ITEM	PURPOSE	MAJOR EQUIPMENT
2.19	Paralle1 running of three-phase synchromous generator	theory of parallel running of synchronous generators. synchronization. load sharing	three-phase synchronous motor-generator, starter, field regulators, synchronism indicator, A.C.voltmeter, frequency meter, three-phase wattmeter, three-phase power-factor meter, A.C.ammeter, D.C.voltmeter, D.C.ammeter, phase meter
2.20	Starting test and characte- ristics test of a three-phase synchronous motor	operation of a three-phase synchronous motor, phase character, load character	three-phase synchromous motor with D.C.generator, starting compensator, field regulators, load apparatus. three-phase wattmeter, three-phase power-factor meter, A.C.voltmeter, A.C.ammeter, frequency meter, D.C.voltmeter, D.C.ammeters
2.21	Characteristics test of a three- phase shunt commutator motor		three-phase shunt commutator motor, electric dynamometer, field regulator, A.C.voltmeter, three-phase wattmeter, three-phase power-factor meter, A.C.ammeter, D.C.ammeters, tachometer, spring balance
2.22	Thyristor	silicon controlled rectifier, principle of rectifier, constructions, characteristics	thyristor, synchroscope, three-phase wattmeter, A.C.voltmeters, A.C. ammeters, D.C. voltermeter, D.C.ammeter, load apparatus
2.23	Automatic voltage adjustment of a D.C.generator using the amplidyne		amplidyne, D.C.motor- generator, D.C.stabilizing power supply, D.C.ammeters, D.C.voltmeter, tachometer, electromagnetic oscillograph, voltage setting comparison apparatus
2.24	Automatic voltage Adjustment of a D.C.generator using thyristors	automatic adjustment of the output voltage of a D.C.genrator using the thyristor and the magnetic amplifier	D.C.motor-generator, thyristor automatic voltage regulator, electromagnetic oscillograph, synchroscope, D.C.voltmeter, D.C.ammeter, tachometer
2.25	Automatic Speed control of the VS motor	construction and characteristics of the VS motor. principle of automatic speed control	VS motor, VS motor control system, electric dynamometer, three-phase wattmeter, A.C.voltmeter, A.C.ammeter, D.C.ammeter, electromagnetic oscillograph

			Table 3-7	. (8)	.
Details	of	Mode1	Electrical	(8) Engineering	Laboratory

ITEM	PURPOSE	MAJOR EQUIPMENT
2.26 Automatic operation of a motor by the sequence control	sequence control	three-phase induction motor, electromagnetic contactors, push-button switches, timing relay, auxiliary relay
3. HIGH VOLTAGE		
3.1 High voltage experiment	high voltage test of electric equipment and facilities	high voltage testing device
3.2 Sparking discharge test	Graduation of a voltmeter using the sphere gap. relation betwen the discharge voltage, the gap length and electrode shapes	high voltage testing device, stardard sphere gap, bar gap, disc electrode, electrostatic voltmeter, A.C.voltmeter
3.3 Breakdown test	breakdown test methods of insulating materials and insulating oil. insulating characteristics of materials	high voltage generator, insulating material testing equipment, insulating oil withstand voltage testing device, A.C.voltmeter, electrostatic voltmeter A.C.ammeter
3.4 Impulse voltage generator	operation of an impulse voltage generator. starting characteristics. measurement of the utilization factor and the output characteristics	A.C.high voltage generator, high voltage rectifier, impulse voltage generator, control panel. speed triggered sweep Brown tube-oscilloscope, klydonograph
3.5 Insulator test	dry flashover voltage test impulse flashover voltage test	A.C.high voltage testing device, implulse voltage generator, high speed triggered sweep Brown tube oscillograph, insultators
4. TRANSMITTION AND DISTRIBUTION		
4.1 Relays	the construction features of the inductive overcurrent relay and its testing method	A.C.ammeter, A.C.voltmeter, frequency meter, cycle counter, load resistor, switches
4.2 Characteristics measurement of the transmission line using imi- tated transmi- ssion line	measurement of the circuit constants and the characteristics of a transmission line	A.C.voltmeters, ammeters, one-phase wattmeter, slidacs, power-factor line, switches, power factor regulation load appratus, artificial transmission line device

Details	of	Model	Table 3-7 Electrical	(9) Engineering	Laboratory
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ITEM	PURPOSE	MAJOR EQUIPMENT
5. LIGHTING		
5.1 Voltage charac- teristics of incandecent light	relation among the light intensity, power consumption, current, resistance and voltage	D.C.voltmeters, D.C.ammeters, slide rheostat, voltage divider, photometer
5.2 Characteristics of fluorescent lamps		wattmeter, A.C.voltmeters, A.C.ammeter, slidac, variable capacitor, stabilizer, glow lamp, switch, capacitor for limiting noise, fluorescent lamps
5.3 Measurement of illumination intensity		illuminometer
5.4 Measurement of the light intensity and the distribution curve of light		photometer, D.C.voltmeters, D.C.ammeters, slidac rheostat, voltage divider, standard lamp, switches
5.5 Measurement of the light flux using a light- flux meter		D.C.voltmeters, D.C. ammeters, rheostats, sphere type flux meter, standard lamp, lamp for comparison
6. ELECTRONICS		
6.1 Electronic refrigeration	characteristics of the electronic refrigeration elements and the power supply	power supply device, thermoelectric elements
6.2 High frequency inductive heating	principle of the inductive heating. operation of a high frequency heating device	high frequency inductive heater, shore durometer, beaker, thermometer
5.3 Characteristics of the vacuum tube voltmeter	measurement of the sensitivity and frequency characteristics of a vacuum tube voltmeter	various vacuum tube voltmeters, A.C.voltmeter, slidac, standard signal generator, low frequency oscillator, switches, fixed resistor
6.4 Measurement of circuit cons- tants in a high frequency range using Q meter	principle of Q meter	Q meter, LCR meter, coils, capacitors
6.5 Static characteristics of vacuum diode		D.C.ammeters, D.C.voltmeters, eliminators, slide rheostats, switches, vacuum diodes

**********	ITEM	PURPOSE	MAJOR EQUIPMENT
6.6	Static characteristics of triode		D.C.ammeters D.C.voltmeters eliminators, slide rheostats, switches, triodes
6.7	Static characteristics of tetrode and pentode	measurement of the static characteristics of tetrode and pentode. function of a screen grid and a suppressor grid	D.C.voltmeters, D.C.ammeters, eliminators, slide rheostats, switches, tetrodes, pentodes
6.8	Characteristics of discharge tube	measurment of the characteristics of a voltage regulator tube and thyratron	voltage regulator tube, thyratron, D.C.voltmeters, D.C.ammeters, slide rheostats, eliminators, switches, fixed resistors
6.9	Static characteristics of photo tube	measurement of the relation between the incident light flux and the photo current	standard lamp, D.C. voltmeter, A.C.voltmeter, D.C.microammeter, slide rheostat, eliminator, slidac, switches, fixed resistors, photo tubes
6.10	Characteristics of diode	measurement of the characteristics of the silcon and germanium diode (point contact and junction)	D.C.voltmeter, D.C.ammeters, D.C.power supply, slide rheostat, switches
6.11	Characteristics of thermistor and varistor		D.C.voltmeter, D.C.ammters, batteries, slide rheostat, galvanometer, electric heater, wheatshone bridge, switches, slidac, beaker, thermometer, thermistor varistor
6.12	Static Characte- ristics of tran- sistor		D.C.voltmeters, D.C.ammeters, batteries, slide rheostat, switches, transistors
6.13	Synchroscope		synchroscope, slidac, signal generator, pulse generator, D.C.voltmeter, A.C.voltmeter, vacuum tube voltmeter, battery, fixed resistors, capacitors, slide rheostat
6.14	Measurement of vacuum tube constants	measurement of vacuum tube constants using a A.C.bridge	low frequency oscillaor, eliminators, slide rheostats, D.C.voltmeters, D.C.ammeter, wave detector, mutual inductor, various resistors

Table 3-7 (10) Details of Model Electrical Engineering Laboratory

ITEM	PURPOSE	MAJOR EQUIPMENT
6.15 H parameter of transistor		low frequency oscillator, D.C.voltmeters, D.C.milliammeter, vacuum tube voltmeters, eliminators, slide rheostats, resistors, transistor tester, transistors
6.16 Measurement of the static characteristics of the SCR	static characteristics of the silicon controlled rectifier	SCR, D.C.power supplies, low frequency oscillator, D.C.voltmeters, D.C.milianmeters, slide rheostats, resistors, variable resistors, sychroscope, circuit tester, change-over switches
6.17 Characteristics of the low fre- quency voltage amplification circuit using vacuum tube	measurement of the characteristics of low frequency voltage amplifiers using vacuum tubes (resistance amplifiers tranformer- coupled amplifiers, chalk- capacitor coupled amplifiers)	amplifiers, eliminators, variable resistance attenuator, low frequency oscillator, vacuum tube voltmeter, synchroscope, fixed resistors, capacitors, low frequency choking coil, change-over switches, circuit tester, phase meter
6.18 Characteristics of the low fre- quency voltage amplifiers using transis- tor	measurement of the characteristics of low frequency voltage amplifiers using transistors (resistance amplifiers, transformer- coupled amplifiers)	amplifiers, battery, variable resistance attenuator, low frequency oscillator, vacuum tube voltmeter, synchroscope, change-over switches, circuit tester, fixed resistor
6.19 Characteristics of the negative feed-back amplifier		amplifiers, low frequency oscillator, variable resistance attenuator, vacuum tube voltmeter, synchroscope, circuit tester, fixed resistors, capacitor, change-over switches
6.20 Characteristics of the low fre- quency power amplifiers using vacuum tubes	measurement of the optimum conditions of the vacuum tube power amplifiers and calculation of the efficiency	amplifiers, eliminators, vacuum tube voltmeters, D.C.voltmeters, D.C.ammter, low frequency oscillator, output transformer, circuit tester, rheostat, synchroscope, wattmeter
6.21 Characteristics of the low fre- quency power amplifiers using transi- stors	neasurment of the optimum conditions of the transistor power amplifiers and their characteristics	amplifier, D.C.voltmeter, vacuum tube voltmeters, D.C.ammeters, rheostat, low frequency oscillator, output transformer, battery, synchroscope

Table 3-7 (11)Details of Model Electrical Engineering Laboratory

Details	of	Model	Table 3-7 Electrical	(12) Engineering	Laboratory

	ITEM	PURPOSE	MAJOR EQUIPMENT
6.22	Characteristics of the vacuum tube medium frequency amplifiers		amplifer signal generator, input impedance, load resistor, synchroscope, eliminator
6.23	Characteristics of the vacuum tube high frequency amplifiers		high frequency amplifier, signal generator, vacuum tube voltmeter, eliminator, capacitors, circuit tester
6.24	Wide band amplifiers		amplifier, eliminator, low frequency oscillator, signal generator, pulse generator, synchroscope, variable resistance attenuator, change-over switches, high frequency chalking coils, capacitors, fixed resistors
6.25	Transistor video frequ- ency amplifiers	measurement of the characteristics of the transistor video frequency amplifiers and the emitter follower amplifier	video frequency amplifier, signal generator, vacuum tube voltmeter, synchroscope, fixed resistor, capacitor
6.26	Characteristics) of the D.C. amplifier		amplifier, D.C.voltmeters, batteries, D.C.vacuum tube voltmeter, eliminator, D.C.ammeter, slidac, A.C.voltmeter, slide rheostat
6.27	Characteristics of the back- coupling oscillator	measurement of the characteristics of the Hartley circuit	back-coupling oscillator, eliminator, D.C.voltmeters, D.C.ammeter, high frequency fixed resistors, battery, switches, signal generator, wave detector, synchroscope, high frequency transformers, low frequency transformer
6.28	Characteristics of the CR oscillator	the characteristics of a CR oscillator and the comparison with the back- coupling oscillator	oscillator, eliminator, D.C.voltmeter, rheostats, variabl capacitors, thermister, synchroscope, low frequency oscillator, slidac, A.C.voltmeter
5.29	Measurement of the characteri- stics of the AM modulation circuit	measuremnt of the carrier, signal wave and modulation percentage	modulator, D.C.voltmeters, D.C.ammeter, eliminators, signal generator, low frequency oscillator, synchroscope, change-over switch, vacuum tube voltmeters

Details of	Model E	Table 3-7 lectrical	(13) Engineering	Laboratory

ITEM	PURPOSE	MAJOR EQUIPMENT
6.30 Measurement of the characteri- stics of the AM detection circuit	diode wave detection, plate detection and grid detection of the AM modulated wave	wave detector, eliminators signal generator, low frequency oscillator, D.C.voltmeters, capacitors synchroscope, vacuum tube voltmeters, high frequency smplifier
6.31 Measurement of the character- istics of the FM modulation circuit	measurement of the frequency modulation characteristics of the FM circuit using reactance tubes	modulator, eliminators, D.C.voltmeter, heterodyne wavemeter, synchroscope, capacitors, fixed resistor
6.32 Measurement of the character- istics of the FM demodulation circuit	Foster-Seely circuit, and Ratio circuit	demodulator, signal generator, D.C.vacuum tube voltmeter, micro ampere meter, eliminator, circuit tester, fixed resistors
6.33 Characteristics of a rectifier with smoothing circuit	voltage regulation of a rectifier with smoothing circuit. measurement of ripples and rectification efficiency	rectifier, A.C.voltmeter, A.C.wattmeter, D.C.voltmeter D.C.ammeter, vacuum tube voltmeter, slide rheostat, switches, slidac, synchroscope
6.34 Transient phenomenon of of the RC circuit	measurement of the charge and discharge characteristics of the RC circuit and the application of the RC circuit to a pulse circuit	D.C. power supply, D.C. voltmeter, D.C. microammeters, switches, fixed resistors, capacitors, stopwatch
6.35 Clipper, slicer, clamping cir- cuit, differen- tial circuit, integration circuit	wave shaping circuits	clipper, clamp circuit, differential circuit, integration circuit, battery, D.C.voltmeters, capacitors, fixed resistors, signal generator, non-sinusoidal waves generator, synchroscope
6.36 Measurement of the characteri- stics of the multivibrator	waveformsat each electrode of a multivibrator and their application to electronics circuits	astable multivibrator (vacuum tube), astable multivibrator (transistor) bistable multivibrator, eliminator, battery, fixed resistors, capacitors, D.C.Voltmeters, D.C.ammeters, synchroscope amplifier, nonsimusoidal waves generator

11	'EM	PURPOSE	MAJOR EQUIPMENT
the stic saw	urement of characteri- s of the tooth llator	measurement of the characteristics of saw tooth oscillators using discharge tubes	saw tooth oscillator using diode discharge tube, saw- tooth oscillator using thyratron, eliminators, D.C.voltmeters, D.C.milliammeter, nonsinusoidal wave generator, amplifier, capacitors, fixed resistors, synchroscope
the stic resi	urement of characteri- s of the stance nuator	understanding of the four terminal network by the measurement of the characteristics of a resistance attenuator	low frequency oscillator, level meter, change-over switch, fixed resistors, high frequency variable resistor
		to construct a filter circuit of simple elements and to measure its characteristics	variable induction-box, variable capacitors, low frequency oscillator, variable resistance attenuator, vacuum tube voltmeter, change-over switches load resistor, artificial line (low frequency)
5.40 Anal nons wave	lnusoidal	to analyze nonsinusoidal waves and to investigate what characteristics of amplifiers are required for nonsinusoidal waves used in electronic circuit	nonsinusoidal waves generator (triangle waves, rectangular wave, pulse wave), variable high pass filter, variable low pass filter, synchroscope, load resistors, Klirrfaktormeter, change- over switch, nonsinusoidal wave circuit
. TELECO	MMUNICATION	······································	
natu enci ante	urement of ral frequ- es of nna and nna constant		antenna, signal generator, heterodyne wavemeter, high frequency ammeter, high frequency transformer, variable high frequency resistor, standard inductances, switch
the tics	urement of characteris- of the er wire	to measure the characteristics of a Lecher wire. to understand the standing wave and the characteristic impedance. to learn about ultrashort waves	ultrashort wave signal generator, loose coupling high frequency transformer Lecher wire, high frequence ammeter, vacuum tube voltmeter, high frequency variable resistor,

Table 3-7 (14) Details of Model Electrical Engineering Laboratory

Table 3-7 (15)Details of Model Electrical Engineering Laboratory

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ITEM	PURPOSE	MAJOR EQUIPMENT
7.3 Measurement of the cahracteris- tics of a loudspeaker	measurement of the characteristic of the cone type dynamic loudspeaker and combination with amplifier	low frequency oscillator, low frequency amplifiers, transformer, loudspeaker, condenser microphone, resistance attenuator, vacuum tube voltmeters, sounder, change-over switch, synchroscope, acoustic experiment equipment
7.4 Characteristics of a receiver	measurement of the noise limiting sensitivity and selectivity of a receiver	receiver, load circuit, artificial antenna, signal generator, change-over switch, high pass filter, band pass filter, level meter, vacuum tube voltmeter, synchroscope
7.5 Transmitter	adjustment of a radio transmitter	radio transmitter, artificial antenna, illuminometer, D.C.power supply, D.C.ammeter, D.C.voltmeter, low pass filter, resistance attenuator, vacuum tube voltmeter, pickup coil, synchroscope, change-over switch, frequency meter
7.6 Relays for communication		relay kit, D.C.ammeter, D.C. power supply, galvanometer, standard variable resistor, standard capacitor, circuit tester, register, synchroscope, electronic counter, oscillograph
7.7 Adjustment of a superhetero- dyne receiver		superheterodyne receiver, signal generator, synchroscope, circuit tester, vacuum tube voltmeter, capacitors, D.C.ammeter, fixed resistors
7.8 Adjustmet of the television receiver		television receiver, sweep oscillator, oscilloscope, low frequency oscillator, vacuum tube voltmeter, circuit tester, fixed resistor, capacitor, marker generator
7.9 Measurement of ultrashort waves	measurement of the characteristics of the klystron and the standing wave in a microwave circuit	microwave experiment equipment, microampere meter, oscilloscope, amplifier

ITEM	PURPOSE	MAJOR EQUIPMENT
3. CONTROL		
8.1 Analog computer	circuit of an analog computer and programming to solve differential equations	D.C.amplifier, synchroscope, square wave generator, rheostat, fixed resistors, capacitors, analog computer, oscillograph
8.2 Measurement of the indicial response in the temperature sensor and the electric furnace	to understand the transfer function by measuring the characteristics of the equivalent circuits of a temperature sensor and an electric furnace in a automatic control system	thermocouple, electric furnace, A.C.wattmeter, A.C.ammeter, A.C. voltmeter, D.C.amplifier, oscillograph, X-Y recorder, thermometer, slidac
8.3 Characteristic measurement of a differential transformer	characteristic measurement of a differential transformer which is used to detect linear and angular displacement	slidac, differential transformer, vacuum tube voltmeters, synchroscope, micrometer, rheostat, variable capacitor
8.4 Bode diagram of the CR compen- sation circuit	to understand the transfer function and the stability criterion by drawing the Bode diagram	ulgralow frequency oscillator, oscillograph, fixed resistors, capacitors battery, rheostat
8.5 Characteristic measurement of an A.C. servo- motor	measurement of the characteristics of a two- pahse servomotor. servomotor in an automatic control system	servomotor, spring balance, slidac, oscilloscope, stopwatch, A.C.voltmeters, A.C.ammeter, pully, capacitors, fixed resistor
8.6 Characteristic measurement of FET transistor	measurement of the static characteristics of FET transistor using synchroscope	eliminator, vacuum tube voltmeter slide rheostat, synchroscope, low frequency oscillator, FET transistors transistor (2SC32A), diode, fixed resistors, switches, D.C.amplifier
8.7 Characteristics of logic circuit		pulse generator, dual trace synchroscope, logic circuit rheostat, battery, switches
8.8 Characteristic measurement of analog IC		compensation amplifier, D.C.power supplies, variable voltage power suplies, switches, input resistors, load resistors, capacitors, signal generator, pulse generator, synchroscope
8.9 Characteristic measurement of digital IC		pulse generators, eliminators, synchroscope, milliammeter, D.C. voltmeter, thermostat, thremometer, 20R-2AND, DTL 3-input NAND gate (TD 1001) operational amplifier

		Table 3-7	(16)	· · · · · · · · · · · · · · · · · · ·
Details of	Model	Electrical	(16) Engineering	Laboratory

Table 3-8 (1) Actual Activities in Electrical Engineering Laboratories

	Theme	usu	UNSRI	ÛNTAN	UMA	UDA	UISU
1. Ele	ctric Circuit			a)			b)
1.1	Ohm's law	*			*		
1.2	Kirchhoff's law	*			*	*	
1.3	D.C. circuit	*					
1.4	Series circuit		*		*		
1.5	Parallel circuit		*		*		
1.6	R-C-L circuit	ň			*		
1.7	Breakdown voltage of R, C and L	· · · · ·	·		<u> </u>	*	
1.8	A.C. circuit	*	·				
1.9	Voltage and current in a R-C-L circuit	*					
	Change of the voltage and current with the frequency change in the R-C-L circuit	*					
1.11	Four terminal network	*			. *	*	
1.12	Thevenin and Norton theorem	*	*		*	*	
1.13	Superposition principle				*	*	
1.14	Electric power	*	·		*	*	
1.15	Improvement of power factor				*	*	
1.16	Phase shift			·		*	
1.17	Transient phenomena	}				*	
1.18	Resonance						
1.19	Three phase system	*					
1.20	Mutual induction	*					
1.21	Network				*		
2. Ele	ctric Measurement		c)	d)			
2.1	Electric measurement instruments	*			*		
2.2	R-C-L elements	*					
2.3	Circuit meter					*	
2.4	Electronic circuit meter						
2.5	Potentiometer					*	
	3 - 75	f					

	Theme	USU	UNSRI	UNTAN	UMA	UDA	UISU
2.6	Wheatstone bridge	<u>_</u>			*	*	
2.7	Range of ammeter and voltmeter	·				*	
2.8	Calibration of D.C. ammeters and voltmeters	*					
2.9	Thermocouple		L		المتحدث المسلم	*	
2.10	Measurement of earthing resistance	*		 	*	* * *	
2.11	Measureemnt of iron core loss	*				*	
2.12	Wattmeter	*				*	· · · ·
2.13	Integrating wattmeter				*	*	
2.14	Measurement of 1-phase electric power				*		
2.15	Measurement of 3-phase electric power				*		
2.16	Illuminometer	*					
2.17	Oscilloscope	*					
3. Ele	ectric Machines						
3.1	Transformer		*	*	*	*	
3.2	1-phase transformer	*					
3.3	3-phase transformer	*					
3.4	No-load, short-circuit and load tests of 1-phase transformer	· ·			*		
3.5	Motor		*	*			
3.6	D.C. motor	*			1	*	
3.7	Induction motor	*				*	
3.8	Running, stopping, reverse running, load tests of 1-phase induction motor				*		
3.9	Running, stopping, reverse running, load tests of 3-phase induction motor				*		
3.10	Synchronous motor	*	 				[
3.11	Three phase synchronous motor				*		
3.12	Three phase synchronous motor	*			*		
3.13	Cage type synchronous motor		*			<u> </u>	<u>}</u>
	Shunt synchronous motor		*				

Table 3-8 (2) Actual Activities in Electrical Engineering Laboratories

Table 3-8 (3) Actual Activities in Electrical Engineering Laboratories

	Theme	USU	UNSRI	UNTAN	UMA	UDA	UISU
3.15	D.C. generator	*					
3.16	No-load, short-circuit and load tests of D.C. generator				*		
3.17	One phase synchronous generator	*				*	
3.18	Three phase synchronous generator				*	*	
3.19	No-load, short-circuit and load and parallel operation tests of 3-phase synchronous generator				*		
3.20	Three phase synchronous generator				*		
3.21	D.C. machines	······	*	*		·	
3.22	A.C. machines			*			
3.23	Converter	*			*		
4. Hi	gh Voltage Technology		e)	f)			
4.1	Measurement of D.C. high voltage	*			*		
4.2	Measurement of A.C. high voltage	*			*		
4.3	Breakdown voltage of gas insulation	*			*		
4.4	Breakdown voltage of oil-immersed transformer	*	`		*		
4.5	Corona characteristics and corona voltage	*			*		
4.6	Electric field distribution on connected insulators	*			*	· · · ·	
5. Tra	insmission and Distribution						
5.1	Thermal relay	*	g).	h)			
5.2	Measuring relay	*				· .	
5.3	Overcurrent relay	*					
5.4	Inverse time-over current relay	*					
5.5	Directional earth fault relay	*					
5.6	Differential relay	*					
5.7	Detection of cable errors using a cable fault locator	*			*		
5.8	Load simulation				*		
5.9	Load balance in the three phase system				*		
5.10	Electric power system experiment					*	

Theme	USU	UNSRI	UNTAN	UMA	UDA	UISU
5. Electronics			i)			
6.1 Diode	*			*		
6.2 Rectifying circuit	*			*	*	
6.3 Transistor and its application	*			*	. *	
6.4 Amplifiers	*			*	*	
6.5 Thyristor	*			*	* * *	
6.6 TRIAC	*					
6.7 Operational amplifier	*			*		
6.8 Oscillator	*			*	*	
6.9 Multivibrator	*			*	*	
6.10 Thermistor					*	
6.11 Photocell					*	
5.12 Electronics timer	*					
6.13 Electronics circuit		*				
. Telecommunication						
7.1 Measurement of fidelity	*					
7.2 Measurement of sensitivity	*			1.1		
7.3 Measurement of selectivity	*					
7.4 Frequency filter circuit				* *		
7.5 Tuning circuit				* * 1		
7.6 Resonance circuit		-		*		1
7.7 Cable impedance characteristics and communication efficiency				*	en de ser	
7.8 Oscillation circuit				***		
7.9 Modulation and demodulation				*		
7.10 A.M. Transmitter				*		
7.11 Radio	·***	*	· · · · · · · · · · ·			
. Computer and Control System		· [
8.1 Logic gate and circuit	*				u tenar	
8.2 Characteristics and operation of AND, OR, NOT, NOR gate circuit		·		*		
8.3 De Morgan theorem				* *		1. I

Table 3-8 (4) Actual Activities in Electrical Engineering Laboratories

Table 3-8 (5) Actual Activities in Electrical Engineering Laboratories

	Theme	USU	UNSRI	UNTAN	UMA	UDA	UISU
8.4	Sequential circuits (flip-flop)	*			4		
8.5	Characteristics and operation of flip-flop circuits using IC				*		
8.6	Characteristics of a one bit binary addition and substraction circuits				*		
8.7	Characteristics and operation of comparator circuits	*					
8.8	Characteristics and operation of a BCD decode counter and a BCD to seven segment decoder circuit				*		
8.9	Characteristics and operation of a BCD up and down counter				*		
8.10	Micrprocessor			*	· · ·		
8.11	Analog computer	*	·				

Note : a) There are a number of experiments of electric circuits although the details of themes are not available.

- b) All experiments are conducted at the University of North Sumatera since there are no facilities of its own. The themes of experiments are the same as those at the North Sumatera University.
- c) The details are not available.
- d) The details are not available.
- e) High voltage technology practices are conducted at Bandung Institute Technology since there are no facilities of its own.
- f) High voltage technology practices are conducted at Institute Technology Bandung since there are no facilities of its own.
- g) Transmission and Distribution practices are also conducted at Institute Technology Bundung since there are no facilities of its own.
- h) Transmission and Distribution practices are also conducted at Institute Technology Bundung since there are no facilities of its own.
- i) Basic electronics and power electronics experiments are conducted although the details are not available.

Laboratory Work Category	Laboratory Work Item	Objective and Contents of Study	Major Laboratory Equipment
T. Chemical Analysis	1.1 Qualitative Analysis	Qualitative analysis of inorganic matchyer, cation and anion are carried out using related reagents for qualitative analysis.	Conical Beaker, Magnetic Stirrer, Erienmeyer Flask Voil Pippette, Mescylinder, miscellaneous Reagents, Bunzen Burner, Filter Paper, PH Testing Paper, Dessicator, Drying Oven, Platinum Crucible Filtration Funnel, Beaker,
	1.2 Gravimetric Analysis	Metalic element and Inorganic ion will be gravimetricaly analyzed using necessary reagents.	Conicel Beaker, Magnetic Stirrer, Erlenmeyer Flask Voll Pippetle, Mescylinder, Hot plate, Buzen Burner, Hashing Bottle, Deminelirizer, Glass Filter, Electric Furnace dessicator, Miscellaneous Chemical Reagents
	1.3 Quantitative Analysis	It includes neutralization titration, oxidation reduction titration and precipitation titration.	Conical Beaker, Beaker, Erlenmeyer Flask, Crystallization shale, Filtration Funnel, Aspirater, Mespippette, Voll pippette, Mes Flask, Magnetic Stirrer, Balance
	1.4 Instrumantal Analysis	Handling and Operation procedure are trained by Instrumental Analyzers such as, refractometer, Fluorescent spectrophotometer, Spectrophotometer and/or Gas Chromatography	Refractometer, Fluorescent Spectrophotometer, Spectrophotometer,
II Chemical Engineering practice			
I. Measurement of Physical properties	1.1 Measurement of density of liquid	Density of pure liquid and lon mixture of liquid are measured by picre meter in reference to a volume precisely determined by deminelerized water	Picremeter, Brying Oven, Balance, Constant Temperature Bath, Thermostat
• ••	Measurement viscosity of	Viscosity of pure liquid and/or mixture of liquid Ostwald Type Viscosimeter, are measured. Variations of limit any momented of Analysian function of Soft), S	Ostwald Type Viscosimeter, Constant Temperature Bath, Rubber Tuse (soft), Stopwatch, Drying Oven Annianter Ebrigmeter (200 ml) Thommometer
	A.D RESSULEMENT OL VADOUT PRESSURE	Apour pressure of light description.	Aspiraters buildmeter, out must include type) Mercury manometer, Buffer vessel (pressure type)
	1.4 Correction of Thermometer	Thermometer is corrected using by freezing point methanol Boiling point method.	Thermometer, Erlenmeyer Flask (200 ml), Gas Burner, Tripod, Asbestos Net, Circular Flask, Boilingstone, Jacketed Cylinder, Rubber Stopper letc.
2. Fluid Experiment	2.1 Measurement of flow rate of fluid	Flow rate of fluid is measured by specified orifice flow meter and its measurement are compared with calculated value by a difference pressure before and after the orifilce.	Fater Tank, Centrifugal Pump, Bead Tank, Orifice type Flow Meter, Manometer, Control Valve, Receiver Tank, Orifice Plate(Miscellaneous size) pipes (size: 1.5 Inch)

Table 3-9 (1) Details of Model Chemical Laboratory Acitivities

Acitivíties	
Laboratory	
Chemical	-
Model	
of	
Details	
(3)	
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· · ·			
Laboratory Work Category	Laboratory Work Item	Objective and Contents of Study	Major Laboratory Equipment
	2.2 Measurement of pressure loss for	Pressure loss for the packed bed which is packed with glass beads and/or other packing materials	Packed Tower, Blower, Flow Control Devices, Flow Meter (Float Type), Packing Materials (3 kinds)
	packed bed	and introduced by air, are measured, and fozeny	
		by measured value of physical properties of	
		packed particle.	
3. Heat Transfer Operation	3.1 Heat Convection	Using a double-tube type heat exchanger into which water is introduced and steam is charged	Jacket Type Heat txcnanger, Inermometer, Valves (Inlet and Outlet for liquid side), Inlet and Outlot waynes for stasm Flortric Type Boilor
		experimentaly measured and related various	(30 kg/HR). Pressure Gauze for steam, Flow meter
	· .	analysis is carried out	[Liquid], Kes Cylinder, (11, 51) Vent valve, Pump Dver-flow vessel.
4. Distillation	4.1 Simple distillation	Volume Change disllate is measured under three	Sway-flask, Thermometer, Riebig Cooler, Mesflask,
Operation		components simple distillation operation, and	Mantle Heater, Voltage Controler
	· · · · ·	distillation curve is prepared and its data is comparied with theoretical solution and studied	
	4.2 Fractional	Characteristic perforemance index such as H.T.U	Colum with vacuum Jacket (Top.
	Distillation	and HETP are determined for the fractional	still, Cooler(3 pcs), Mantol Beater, Thermometer
	Uperation		
	4.3 uas Absorption by Packed Column	Absorption of oxygen gas into water is operated by packed column and H.T.H. is determined in the	Rescrints wird type facked column, oxygen bome, Orifice type Flow Meter. Over Flow vessel.
		Packed columned.	Thermometer, Pressure Regulator, Do-meter.
		Sands and/or clay balls of uniform size of	Drying Chamber with Balance, Blower, Orifice type
	drying velocity of solid	particle is dryed by hot air and heat transfer coefficient is determined.	
	10 1 14 222211 222		Professional Stopwatch
	eriment of	busserption of P-microphemot solution to pulverized activated carbon is carried out and	bearer(1 w/, measuring rippette, mithing/er rison [with stopper (100 ml)] Deminelirizer. Flourescend
	aromatic compound	parameters for an isothermal adsorption equation	
·	solution to	is determined.	
	pulverized arrivated rarhon		
		Adsorption break-through curve is determined and	Over Flow Tank, Adsorption Tower with Jacket
	Aanlysis of	analyzed for packed fixed bed with granular	Flow Meter, Circulation Pump, Measuring Cylinder
	adsorption break	activated carbon and overall mass transfer unit	Three-way Cock,
	fired bed	- DANTATADAD ET OTN	

Table 3-9 (3) Details of Model Chemical Laboratory Acitivities

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Laboratory Work Category	Laboratory Work Item	Objective and Contents of Study	Major Laboratory Equipment
7. Crystallization	7.1 Crystallization operation	Crystallization operation is carried out by continuous complete mixing vessel type crystallizer and production velocity and core generation Velocity are dtermined	Crystallizaiton Vessel with Draft (500 ml. Acrylate Type), Stirrer, Feed Pump, Thermometer, Constant Temperature Bath, Taylor mesh sieve (No 09-200), Aspirator, Drying Oven, Nuche, Filtration Vessel, Filter cloth, Measuring Beaker (10 pcs) injector, Ammonium Sulfate, Demine
8. Reaction Kinetics	8.1 Dynamics of stirred Vessel	Using an alanin dye as a tracer. Stirred tank is operated and mixing characteristics and dynamics of the vessel are determined.	Transparent Acrylated mixing vessel with Baffle (5 L, Four blades), Head Tank, Oriffice type Flow meter, Feed Tank, Circulation Pump (Centrifugal) U-type manometer, Spectoro photometer, rotation meter
9. Material Handling	9.1 Measurement of particle distribution of solid	Distribution pattern of particle is determined as Andoreazen Pippette, Flyash, Calcium Carbonate using andoreazen pipette method which is deemed a powder (sediment action type), Silicasand, one sedimentation method. Weighing pin Desiccator, Meausring Cylinder,	Andoreazen Pippette, Flyash, Calcium Carbonate powder (sediment action type), Silicasand, Hexamethalic acid soda, Chemical Balance, Veighing pin Desiccator, Meausring Cylinder,
	9.2 Filtration experiment	Coefficient of Filtration, filtration volocity and characteristic of washing are determined by diatomaceous earth	Slurry mixing vessel, Leaf Filter with Filter Cloth (Polypropyrene) Measuring cylinder for Filtrate, Measuring cylinder for washed filtrate
			Mercury type mano meter (closed cype), Aspirator, Needle valve for pressure control, two-way cock, three-way cock

Laboratory Work	UNSYIAH	USU	UNSRI	Remarks
1. Chemical Analysis	·····		·	<u>.</u>
1.1 Qualitative Analysis	t *	*	*	·
1.2 Quantitative Analysis	*	*	*	
1) Titration Analysis		*	*	
2) Gravimetric Analysis	<u></u>	*	*	- 1
3) Instrumental Analysis	*	*	·	<u> </u>
2. Chemical Engineering Experiment	····· <u> </u>		1	••••••••••••••••••••••••••••••••••••••
2.1 Simple Distillation	-	*	*	
2,2 Heat Convection	*	*] -	
2.3 Spray Drying	 -	*	*	·
2.4 Mass Transfer Operation in Wetted Wall Column		*	-	
2.5 Filtration	*	*	-	
2.6 Fractional Distillation		*	1 ~	- I
2.7 Fluidization	*	- 1	1 -	
2.8 Mass Transfer in Fixed Bed	*) *	1
2.9 Liquid-Liquid Extraction	*		*	
2.10 Measurement of Heat Conductivity	 -		*	
2.11 Gas-Liquid Absorption	-	-	*	
3. Chemical Process Experiment	<u></u>		1	·/
3.1 Fermentation of Starch			1	
3.2				- I
3.3 Manufacture of Pulp		*	-	, <u></u>
3.4 Esterification		*	*	<u> </u>
3.5 Synsesis of Urea-Formaldelyde	┸┈┈┈╍╾╂╶ _{╌╴} ╎╶╸ ╎	*		<u></u>
4. Micro-Biology	-لىمىنىيەن بىرىكى مېر 		±	- <u>t</u>
4.1 Starch Fermentation	┺╼╼╼╼╼╼╼┺╴╼╼╼ ┨ ╶ ┙╴┨		*	-
4.2 Micro Organism	ل لہے۔۔۔۔ا ۔۔۔ ا ۔ ۔ ا		 } *	

Table 3-10 Actual Activities in Chemical Engineering Laboratories

Laboratory Work	Laboratory Work Item	Objective and Contents of Study	Major Laboratory Equipment
Lategory 1. Work Engineering	1.1 Fork time Measurement	Determination of Standard work time and consideration of work facilities and equipment in relation to worktime are carried out through time measuremnt for related work item.	Stopwatch, Video recorder, Memo motion apparatus, Micrometer
	1.2 Design of Work System	Work system is designed through a study of the efficiency of the work together with identification of the results of the work time measurement.	8 m/m VTR, Meno-motion apparatus, stopwatch, VTR, Micrometer, Slide screen
	1.3 Fork Sampling Analysis	In order to get a quick Judgment of operating condition of workers and/or machine, spot observations of the target work at randam period and overall activities for the work is estimated for whole time of the work.	Tiemswitch, stopwatch, Randam time table, Randam number table, observation sheet, VTR, P/C
2. Factory Layout Planning	2.1 Study of Lay out plan of Factory	Layout plan of a existing factory is studied and a justification of this is analyzed in consideration of manufacturing process and worker's operation, area.	Scale facility model, Layout plate, Camera, 8 m/m VTR, Vertical drafter, Drafting tools, Scale Box
	2.2 Design of Layout plan	Layout plan of a specified plant is design through understanding of process, configuration of Equipment and machine, and role of workers.	Educational slide, Drafter, Template, T-square, Scale layout model, Tracing table for perspection Copying machine, Facility scale plate
3. Statistic Engineering	3.1 Analysis of parameters influencing quality of a product	Characteristics of a product is analyzed by miscellanious parameters influencing the product in consideration of the results measured for the product.	P/C, Sampling Tools, 8 m/m VTB
	3.2 Statistical analysis of frequency of presence of alphabetical characters	Per-centage of alphabetical characters at various book in vavious languages is researched and analyzed by linear regression equations.	Random Number Table, P/C, Distribution model, 20-hedron Disc
4. Computer Engineering	4.1 Computer Programming	Operating procedure and utilization of software package are trained and programming is practicaly carried out.	P/C, Software, Autofile
	4.2 Computer Simulation	A Performance characteristics of a system is simulated by formulating a independent parameter to dependent ones keeping the system as black box	P/C

Table 3.11 DETAILS OF MODEL INDUSTRIAL ENGINEERING ACTIVITIES (1/2)

8 m/m VTR, Screen Slide, Educational Trans-Major Laboratory Equipment. Small size lathe, parency Understanding of Practical criteria for safety problems, working practical guide line circumstances, hazordas materials and toxic for environmental materials is trained. Machine component of machinery parts is manufactured and analyzed of its performance and identification in the production machine Objective and Contents of Study 5. Unufacturing Process 5.1 Manufacture of Technology Machine Component for environmental instruments Laboratory Work Item 6.1 Understanding of 6. Environmental Laboratory Work Engineering Category

Table 3.11 DETAILS OF MODEL INDUSTRIAL ENGINEERING ACTIVITIES (2/2)

instruments

Various environmental analytical instruments | 0xygen meter, Vibration Meter, Hydro carbon such as vibration meters, gas detectors, Lux mete Aanlyzer Lux meter, Hazardas gas detector, are trained.

device.

			UISU	UMA
Laboratory Work	บรบ	UDA	0120	UPIA
1. Work Study		 	<u> </u>	<u> </u>
1.1 Work Measurement	*	*	*	*
1.2 Design of Work System	*	*	<u> </u>	*
1.3 Work Sampling	*	<u> </u>	*	*
2. Factory Layout Plan			<u> </u>	L
2.1 Layout Study	*	*	*	*
2.2 Planning of Layout Plan	*	*	*	*
3. Statistic Analysis	1		<u> </u>	
3.1 Analysis of Parameters relating to quality of product	*	· *,	*	*
3.2 Statistical Analysis Method	*	-	*	-
4. Computer Engineering				L
4.1 Computer Programming	*	*	*	*
4.2 Computer Simulation	*	-	-	-
5. Machine Processing Technique	1	1		
5.1 Manufacture of Machine Element	*	-	_ ^{>}	-
6. Environmental Engineering				
6.1 Environment Design	*	-		
6.2 Environmental Analysis Instrument and their Application	*	-	~	-

Table 3-12 Actual Activities in Industiral Engineering Laboratories

Name of Laboratory	Name of Experiment	Objects and Contents of Experiment	Major Equipment
1. Geology Lab.	1.1 Basic Geology	To study sedimental structure through models	Sediments' Model
an Appanent and a second Appanent and a Appanent and a Appanent and a	1.2 Basic Rock- Mineral Analysis	To study composition and crystal structure of rocks and minerals	Rock-Mineral Models Sections, Crystal models, Reflex and stereo microscope
	1.3 Geological	To study the way of geo- logical survey through field training or to study the geological structure through Aero- photography	Stereoscope, Clino- meter, Geological hammer, Magnifier
2. Mineral Analysis Lab.	Mineral Analy- sis	To analyse rocks and minerals by means of microscopy method of section samples	Stereo microscope, Reflex microscope, Rock cutter/trimmer, Section sample making equipment, Lapping/ polishing machine,
			X-ray fluorescence analyser, Dryer, Crusher, Abbe refra- ctmeter, Hardness tester, Sieves, Balances
3. Land Survey Lab.	Land Survey	To train leveling and traversing technique	Level, Transit, Tripod, Steel tape, Poles
4. Geophysical Prospecting Lab.	Geophysical Prospecting	In general: To prospect location of structure under ground and geolo- gic structure, geomag- netic character, forma- tion resistivity and secismic character at stratication plan will be measured.	
	4.1 Electrical prospecting	To prospect mineral bed (vein), specific struc- ture underground and other geologic struc- ture, formation resis- tivity will be measured.	Electrical prospec- ting system (Resistivity meter, Amplifier, Recorder and others)
	4.2 Electro- magnetic Reflection Profiling	To prospect depth, shape of basement and geolo- gical structure through electromagnetic reflec- tion profiling method. These geological infor- mations are informed as magnetic value of geo- logical layers.	Electromagnetic reflection profiling system (Proton magnetometer, and others)

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Table 3-13 (1) Details of Model Mining Enigneering Laboratories

Table	3-13	(2)	Details	o£	Model	Mining	Enigneering	Laboratories	· · · ·

Name of Laboratory	Name of Experiment	Objects and Contents of Experiment	Major Equipment
	4.3 Seismic Prospecting	P and S-wave transfered through basement and geological layers to be measured to prospect any geological infor- mations under ground.	Seismograph (Seismic Oscillograph Trigger remote con- troller and etc.) Bed detector
	4.4 Radioactive Well Logging	To prospect depth of oil reservoir, gas re- servoir or to constrast geological structures, radioactive ray will be measured.	P-S velocity logging system or Geo logging system
5. Mining Ex- ploitation	Exploitation	In General: To study practical method for ex- ploitation (practical exploitation, intake area detour, grauting at mining road/drive)	
	5.1 Air Compression Testing	As soft ground exploi- tation in general air pressure inside the tunnel will be increased to aviod cave-in and water excude. An air compression testing (experiment) is an experiment to teach safety exploiting through practical simulation	Compressor, Pressure gauge, Air flow meter, Prony Brake and etc.
	5.2 Rock Drilling	To practice rock dril- ling by means of a machine drill or an auger	Machine drill, Drill bit, Rod, Jack, Drifter, Auger, Syncroscope, Electro- magnetic osillograph, Torsion meter, Amplifier, Boring machine, etc.
	5.3 Mud Logging	To evaluate oil showing by quantitative analy- sis of oil or gas content in the mud sample	Gas chromatograph, Hydrometer, Viscosi- meter, Sulfer analyse Nitrogen Analyser, Evaporator, pH meter, etc.
	5.4 Ventilation Testing	To study safety design of mining road by measuring air circu- lation condition	Axial fan, Centrifu- gal fan, Rotating meter, Watt meter, Ammeter, Airometer

Name of Laboratory	Name of Experiment	Objects and Contents of Experiment	Major Equipment
	5.5 Tunnel Safety Design	To practice safety design of coal or ore mining road by studying gas break-out, gas residence, temperature increase and other envi- ronmental breaking out mechanism	Transit, Level, Pocket compass, Respirator
6. Mining Mechanics	Mining Mechanics	In General: To practice operation, installation, maintenance method of equipment necessary for mining engineering	
	6.1 Cutting Resistivity Testing	In order to measure a character of stress propagation and break- ing character, rock sample or discontinuous layer which has a fault or a joint will be looked into of their uniaxial compression strength.	Electromagnetic oscillograph, Resis- tivity torque meter, Dinamometer, Shore hardness tester, Shummit hammer, Shear testing machine Maffle Furnece, Table balance, Constant temperature drying chamber, Penetration resisti- vity testing machine
	6.2 Mining Machine Design	To practice designing for necessary equipment for mining engineering	Drawing table, Drafting machine, Table top calculator
	6.3 Haulage Testing (Off-the- Road Houling)	To practice haulage method of to study cost effective haulage method	Mini conveyor, Shoot, feeder, Small hoist, Scraper, Motor, Hydraulic pump
	6.4 Rope Strength Testing	Testing pull rope and main rope of their strength	Wire fatigue testing machine, Wire rolling testing machine, Wire bending testing machine, Wire torsion testing machine
	6.5 Roof Control and Testing Strut	Measure mine stress to estimate strut or stru- cture's strength	Iron strut, Hinged bar, stress gauge, Resistive torque meter, Recording oscillograph, Photoelasticity testing equiment

Table 3-13 (3) Details of Model Mining Enigneering Laboratories

Name of Laboratory	Name of Experiment	Objects and Contents of Experiment	Major Equipment
7. Mineral Dressing	7.1 Screen Analysis	To make quantitative analysis of mineral or ore samples by means of screening	Standard sleve, Riffle sampler, Sand bath, Infrared dryer, Jaw crusher, Stamp mill, Hanmer mill, Sample grinder, Rod mill, Hot mill
	7.2 Separation Test	To analyse content of rare metal within a vein	Mineral jig, Shaking table, Hydro-cyclone separater, Glass type floating separater, Mechanical floating separater, Magnetic separater, Filtering apparatus, Air flow meter, Liquid flow meter, Muffle furnace, P Nano ammeter, etc.
	7.3 Oil Analysis	API, Evaporation pressure, Viscocity, Sulfer content, Nitogen content, Salinity, Water content, Heavy metal content and other nece- ssary data will be examined to determine quality of oil. (Practice)	Centrifuge plaro- graph, Titlation apparatus, Photoele- ctric colorimeter, Flame photometer, Salinometer, Water content analyser, Infrared spectro- photometer, Spectro- photometer, Sulfer analyser, Ni-analyser etc.

Table 3-13 (4) Details of Model Mining Enigneering Laboratories

Table 3-14 Actual Activities in Mining Enginnering Laboratory

Laboratory Work	UNSRI	UDA
1. Basic geology		
1.1 Basic Study	*	*
1.2 Rock/Mineral	*	*
1.3 Obserbation	*	*
1.4 Field Study	*	* '
2. Mineral Analysis	*	.*
3. Land Surveying	*	*
4. Geophysical Prospecting		
4.1 Electrical prospecting	-	-
4.2 Elctromagnetic reflec-	-	
tion Prospecting		
4.3 Seismic Prospecting	-	
4.4 Radioactive Well	-	
Logging		
5. Exploitation		
5.1 Air Compression Testing		
5.2 Rock Drilling	*	*
5.3 Mud Logging		-
5.4 Ventilation Testing	*	
5.5 Tunnel Safety Desingn	*	••••••••••••••••••••••••••••••
6. Mining Machine		
6.1 Mining Machine Design	_	·····
6.2 Haulage Testing	*	
6.3 Rope Strength Testing	-	·····
6.4 Roof Control and Strut Testing	*	_

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