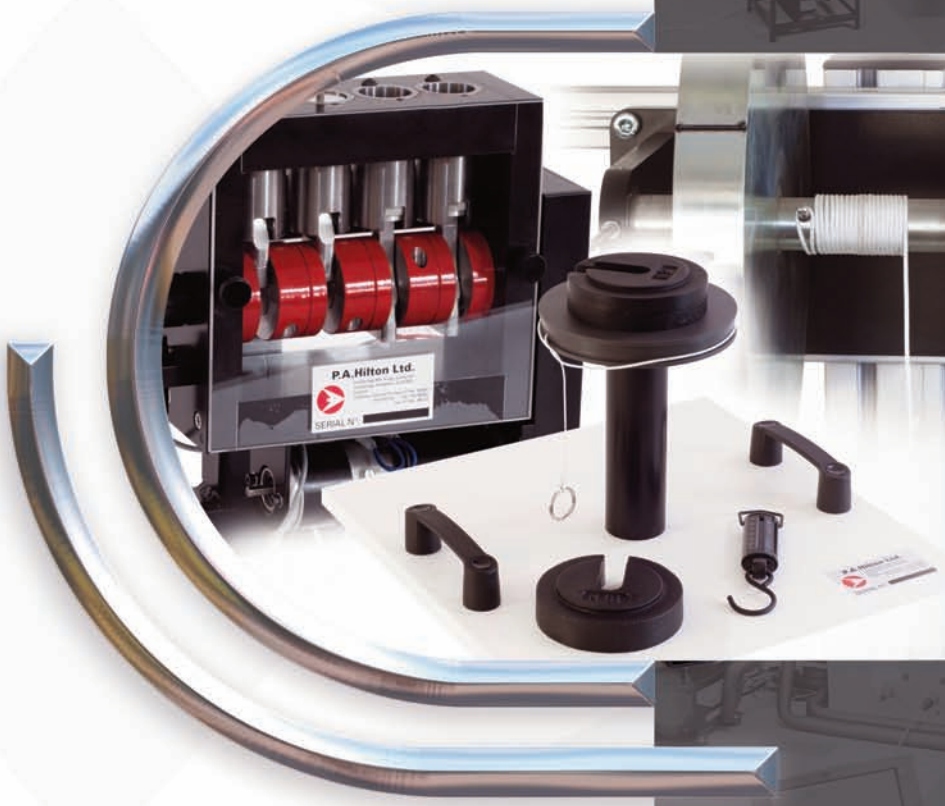
P·A·Hilton Ltd

HI-TECH EDUCATION



THEORY OF MACHINES

DYNAMICS

HI-TECH Education is a market leader in the manufacture and provision of teaching equipment for Universities and Technical Colleges worldwide for both degree and vocational level.

It has been designing and manufacturing "hands-on" Engineering teaching equipment for almost 50 years and has a wealth of knowledge and experience within the educational and training industry. Its worldwide network of agents guarantees a fast and professional response to all enquiries.

The THEORY of MACHINES range of HI-TECH Education equipment enables clear and comprehensive learning of **DYNAMICS** covering a variety of theories and topics. An understanding of the way in which forces act and react, is fundamental when studying the application of loads on a variety of fixed structures and rotating machinery. The THEORY of MACHINES form a comprehensive range of equipment, equally suitable for demonstration and experimental work.

All the THEORY of MACHINES hardware operates in a standalone mode, with a large number being supplied with **Data Acquisition** Interfaces and **Software**. A comprehensive instruction manual for student and lecturer is provided.

2 Two Year Warranty

HTM1 Wheel and Axle

The dual diameter wheel has an axle supported on simple pivots in a sturdy wall mounting bracket. Each wheel has a cord wrapped around its periphery. The cords can be wrapped in either direction around each wheel. A load hanger is added to each cord allowing loading of the wheels using the calibrated weights set provided. Using the hangers and weights allows the experimental determination of velocity ratio and comparison with calculated values. Students can also determine the variation of effort with load and the variation of efficiency with load.

Optional accessories: HAC14

HTM4 Screw Jack

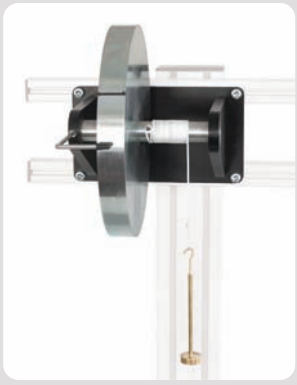
This screw jack is fitted with a large turntable fixed on top of a metric square pitch screw thread. All items are mounted onto a bench top base. Wrapped around the periphery of the large turntable is a cord, which runs off horizontally and over a pulley, allowing the free end of the cord to hang vertical. A load hanger is attached to the free end of the cord to create the driving torque for the screwjack. Depending on the orientation of the cord on the turntable will determine whether the turntable is raised or lowered. Students determine the velocity ratio and compare this with calculated value. They can also determine the variation with load of effort, friction, efficiency and limiting efficiency of the machine.

HTM7 Gear Tooth Form

The gear form apparatus is designed to show and describe how gear teeth are defined and how basic gears work. It also explains the form of an involute curve and how this is used to create a gear tooth profile. To help describe what an involute curve is paper can be placed into the apparatus and an involute curve drawn. Large gears are used on the equipment to show how gears mesh together as well as a gear that can be taken off and measured to help give a practical analysis of the gear form. Completely stand alone apparatus for bench mounting.

HTM8 Cam Analysis

Bench top, self contained apparatus for measuring the rise and fall of a variety of cams supplied. A vertical pillar contains the main spindle for each cam to be rotated, whilst a dial gauge has its anvil resting on the edge of the cam. As the cam is rotated the rise and fall of the cam is monitored using the dial gauge. The protractor and pointer assembly used for the cam allows the angular position to be recorded. Graphs of angular position and cam rise/fall can be plotted from the results. A variety of cams are supplied along with a roller and knife edge follower. The cams and followers are easily changed.



HTM9 Simple Flywheel

Wall mounted apparatus to allow students to verify the second law of motion applied to a flywheel, i.e. the relationship between torque and angular acceleration. They can compare experimental and calculated moments of inertia of a disc as well as study the energy transformations. A disc of 250mm diameter and 30 mm thick is mounted on a shaft running in bearings housed on a substantial wall bracket. A mark on the flywheel and a pointer on the bracket enable the revolutions to be counted and timed with the stop watch supplied. A cord, load hanger and set of calibrated weights are supplied.

Optional accessories: HAC14

HTM17 Crank and Connecting Rod

The apparatus shows the relationship between crank shaft rotation and piston displacement, for a fixed "cylinder". The stroke of the connecting rod and hence piston can be adjusted by securing its end to the different fixing points on the radius of the crankshaft. Crankshaft rotation is measured by a rotating protractor scale and piston displacement is shown on a sliding scale. The crankshaft is rotated manually. The equipment may be mounted vertically for demonstration purposes using the small leg on the rear of the base, or flat on the bench for experimental use.

HTM20 Ackermann Steering

This novel apparatus consists of a complete model Ackerman linkage mounted on a bench mounted base board. It is ideal for demonstration or experimental work and is an aid to understanding the design principles involved. The linkage is fully adjustable so that the Ackerman angles can be varied. The length of the track rods may be altered to demonstrate the effect of mal-adjustment or accident damage. Stub axle displacement is measured by protractor scales. The operation of this apparatus is completely manual.

HTM21 Castor, Camber, King Pin Inclination

This apparatus represents a scaled model of the wishbone and king pin arrangement of a front wheel suspension complete with a wheel on an adjustable stub axle. The king pin assembly includes a steering link to demonstrate how a real car works. It shows precisely how castor, camber and king pin inclination are set and how centre point steering is achieved. Angular scales measure the castor angles and king pin inclination, while toe in and camber angles are measured from a longitudinal and vertical datum in the way in which they would be determined on a real vehicle. A hand driven rotating turntable simulates a rolling road, and may be turned at a slow enough speed to study wheel stability under running conditions.

HTM22 Relationship between Angular and Linear Speeds

A stepped shaft with three diameters is carried in a bracket which can either be clamped in a vice or screwed to a bench. Three adjustable bobs are suspended from individual cords wrapped around each diameter. The bobs have integral screws enabling the starting heights of each bob to be adjusted individually. The shaft is rotated manually by a handle which can be locked by a removable retaining pin. The angular movement of the shaft and the corresponding linear movement of the weights can be compared.

Optional accessories: HAC14

HTM23 Gear Train Demonstrator

A sturdy bench top frame supports all the components on this apparatus. Three movable shafts are mounted to the main horizontal frame member. Onto the shafts sit bearings and the large gears and friction discs. The gear arrangements include gear trains, pulley and belt drives and friction discs. All are mounted onto the shafts in a variety of ways to vary the experiment parameters. The gears are manufactured from durable plastic. Students can arrange single, double or triple gear trains, work with pulley and belt drives. The friction discs also simulate the pitch circle diameter of the main gears. Rotation of the gear arrangements is done manually.

HTM25 Gear Train Apparatus

Small, compact and self contained bench top unit for introducing students to gear trains and epicyclic gears. The base plate holds a horizontal arm which can rotate in a horizontal plane. Onto the arm are attached the main spur gears and their mounting shafts. Multiple fixing holes on the arm allow the gears to be positioned in a variety of arrangements. Four spur gears of different numbers of teeth can be arranged in many combinations of single and compound gear trains. Additionally the mounting arm can be rotated as part of an epicyclic gear train, with the use of sun, planet and crown gears.

HTM66 Static and Dynamic Balancing

A self-contained bench top unit for the analysis of static and dynamic balancing of masses on shafts. Students learn the use of force polygons, couple polygons and vectors. A shaft carries up to four balance masses (non-coplanar) of varying mass. Each mass can be easily adjusted for radius, linear and angular position to vary the imbalance. A set of 12 balance masses are provided of varying magnitude. During dynamic balancing the shaft is run from a speed controlled motor through a pulley and belt arrangement. When static balancing is required the shaft is disengaged from the motor. An attachable shaft, pulley and cord assembly is also used for confirming static balance theory. All rotating parts are covered under a safety guard.

HTM67 Whirling of Shafts

The modes of oscillation and resonance's of rotor shafts can be clearly demonstrated using this bench top unit. A sturdy base frame houses the driving motor, self-aligning bearings, safety guard and test shafts. Due to the use of thin, elastic rotor shafts made of high-strength steel; the oscillatory phenomena can be easily understood. A variety of shaft diameters and lengths are provided for testing and the bearing arrangements can be arranged to create a variety of end conditions. The amplitude of the shaft oscillations is restricted to ensure the shafts do not fail completely. An elastic rotor coupling takes up any alignment issues within the apparatus during rotation.

HTM68 Balance of Reciprocating Masses

Sturdy bench mounted model four-cylinder engine to study the effect of oscillating masses on the vibration behaviour of the machine. Students also investigate different crank arrangements and effect of a weight added to one or more pistons. The model is constructed around a four-cylinder engine held on a cantilever and sturdy vertical pillar. The engine includes crankshaft, connecting rods, pistons, and non-metallic cylinder liners. The crank angles can be individually adjusted to create imbalance. Strain gauging technology transmits the vibrations to a Data Acquisition Interface. A speed controlled motor drives the crankshaft. All rotating elements of the machine are stored away behind a transparent safety guard.

HTM70 Gyroscope

This bench top apparatus studies the moments generated by the gyroscopic effect. A vertical precession motor drives a gyroscopic yoke in a horizontal plane. Within the yoke is a horizontal spin motor and gyroscopic flywheel. The spin axis has a stationary shaft onto which is mounted a sliding balance mass to help vary the gyroscopic moment. The speeds of both motors are independently controlled and displayed on the front panel of the base unit. The gyroscopic yoke is able to displace through small angles between two fixed pins. A transparent safety guard provides protection against the rotating parts.

HTM71 Governors

Bench top apparatus to demonstrate the principle of operation of various governors. A speed controlled shaft allows the governors to rotate in a vertical plane. Three governors are supplied; Porter, Proell and Hartnell. Students can observe the effect of speed of rotation, lifted mass, rotating mass and geometry on the lift of the governor. From this the sensitivity of each governor can be recorded and observed. The sleeve mass of the Porter and Proell governor can be adjusted by the weights set supplied. The Hartnell governor sleeve can be adjusted by the different springs supplied. Students plot graphs and record lengths, masses and distances for each governor. A transparent safety guard provides protection against the rotating parts.

HTM72 Cam Analysis

Bench top apparatus to demonstrate the dynamic investigation of cam and follower mechanisms, as used in motors for actuation of the valves. The cam mechanism consists of 4 interchangeable cams and 2 different cam followers. A mass and spring are used to simulate the valve. To demonstrate "valve bounce", the spring rate, lifted mass, spring compression and speed are all adjustable. A set of springs and added masses are supplied. Each cam is easily interchanged. A Data Acquisition Interface with software is supplied to allow the rise and fall of the cam to be monitored. Valve bounce can be easily observed using the interface and software. All rotating parts are contained within a transparent safety guard.

HTM73 Gear Assembly Unit Combined Drives

Based around a rigid, sturdy frame a variety of drive arrangements can easily be interchanged and fixed into position. Bearing blocks ensure excellent, repeatable alignment of the drives along with smooth running. The drive arrangements include dual belt drive, chain drive with tensioner, spur gear train, dual spur gear, compound bevel gear and spur gear, compound worm / wheel gear and bevel gear, rack and pinion with a spur gear drive. A cranked handle operates the drives giving more control and feel for each drive arrangement. The layout of the drives gives an excellent visual indication of motion, direction, velocity, and mechanical action.

HTM80 Lathe Gear Demonstrator

A sturdy vertical frame holds a number of gears and shafts for demonstrating the operation of a lathe and its associated gearing. The gearing comprises of primary, change, tumbler and quick change gear units, all mounted on precision shafts running in bearings. The shafts and gears can be rotated freely and easily by using the integral crank handle and by manual input. The lathe tool output is simulated using a pen and plotter arrangement. The pen moves in the directions dictated by the lathe gearing and operator and maps out the movements onto a roll of paper.

HTM81 Gear Efficiency

A sturdy frame has a motor mounted along with either a worm or spur gearbox. The input and output power is monitored for determining the gear efficiency of a worm and spur gearbox. The grooves within the frame allow for fine adjustment and easy removal of each gearbox and control component. The motor mounts inside a swinging cradle, which is connected directly to a load cell, allowing the motor torque to be monitored. Each gearbox is attached in turn along with a braking system to load the gearboxes and change the experiment parameters. The motor is accurately speed controlled and along with torque and current displayed on the control box displays.

HTM82 Screw Tester

A sturdy base plate holds a slotted steel beam horizontally. The two part beam allows easy deflection when a standard bolt is tightened into it. The deflection of the two parts of the beam is monitored using a deflection indicator attached at the end of the beam. This deflection is directly related to the tension force generated in the bolt. To reduce the friction a precision thrust bearing is used which the head of the bolt runs on. The torque is applied to the bolt using a torque wrench, lever arm and screw jack mechanism. The screw jack ensures precise loading of the bolt, and the movement of this mechanism is monitored using a second deflection indicator.

OTHER EXPERIMENTS AVAILABLE *(Refer to our Website for details)*

HTM2 Wheel and Differential Axle
HTM3 Worm and Wheel (30 : 1 ratio)
HTM5 Wall Mounted Screw Jack
HTM6 Efficiency of Screw Threads
HTM9a Small Simple Flywheel
HTM9b Comprehensive Flywheel
HTM11 Spur Gear Lifting Machine
HTM12 Critical Speed
HTM13 Epicylic Gear Train
HTM14 Oldhams Coupling
HTM16 Shaping Machine Mechanism
HTM18 Oscillating Cylinder
HTM19 Hooke's Coupling
HTM24 Universal Drive Module
HTM26 Winch
HTM27 Constant Velocity Joint
HTM28 Rotary Cylinder Mechanism
HTM29 Hydraulic Jack
HTM30 Rack and Pinion
HTM31 Watt Linkage
HTM32 Ratchet and Pawl Mechanism
HTM33 Dog Clutch Mechanism
HTM34 Gearbox
HTM35 Coupling Short
HTM36 Coupling Unjoined
HTM37 Braking and Acceleration
HTM38 Disc Brake
HTM69 Geared System
HTM75 Gear Assembly Unit Simple Drives
HTM76 Gear Assembly Unit Step and shift Gears
HTM77 Slotted Link
HTM78 Four Bar Chain
HTM79 Inertia in Rotational Motion
HTM83 Worm Gear Cutaway Model
HTM84 Mitre Gear Cutaway Model
HTM85 Spur Gear Cutaway Model
HTM86 Multistage Gear Combination Cutaway Model
HTM87 Planetary gear Cutaway Model
HTM88 Adjustable Cone pulleydrive Cutaway Model
HTM89 Control Gear Cutaway model
HTM90 Machinary Diagnostic System
HTM91 Differential Crownwheel and Pinion
HTM92 Single Purchase Crab
HTM93 Angular Acceleration
HTM94 Critical Speed Investigations
HTM96 Simple Bearing Housing
HTM97 Motor Driven Scotch Yoke
HTM98 Simple Epicyclic Gear Train

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Represented by: