PROJECT ABSTRACT

Scotch Yoke Mechanism Demonstration Model

A working motorized demonstration model of the Scotch yoke mechanism converting rotary motion into pure simple-harmonic reciprocating motion, with adjustable crank radius (20/30/40 mm), dimensioned fabrication drawings, a motion-timing chart and the full viva kit. Delivered built-to-order.

01. Title

Scotch Yoke Mechanism Demonstration Model.

02. Introduction / Background

The Scotch yoke is one of the canonical mechanisms of the theory of machines: a crank pin riding in a slotted yoke converts continuous rotation into reciprocating linear motion that is exactly sinusoidal — displacement $x = r \cdot \cos(\theta)$, pure simple harmonic motion. Unlike the slider-crank, there is no connecting rod to distort the motion, which makes the Scotch yoke the standard classroom example of exact SHM from a rotary drive. The mechanism appears in small steam engines, pumps, valve actuators and test rigs needing sinusoidal loading. Students, however, usually meet it only as a textbook diagram. A working physical model — crank wheel, slotted yoke block, guided slider rod and motor drive — makes the kinematics tangible: students can change the crank radius, time the cycles, and watch the slider's velocity fall to zero at the dead centres.

03. Problem Statement

Theory-of-machines courses teach the Scotch yoke on paper, leaving students unable to answer practical questions: how the pin stays engaged in the slot, how the yoke is constrained against rotation, how pin-slot clearance distorts the ideal sine curve, and what the real torque and speed limits of a small model are. A demonstration model that is designed, fabricated and measured closes this gap. This project delivers a motorized Scotch yoke model with an adjustable crank radius, graduated stroke scale, motion-timing chart and full fabrication documentation — so the build is both a teaching aid and a complete mechanical design project with calculations, drawings and experimental observation tables.

04. Objectives

- Design a Scotch yoke mechanism with adjustable crank radius (20, 30 and 40 mm pin settings, giving 40/60/80 mm stroke).
- Fabricate the model from workshop-grade materials: mild-steel yoke block and brackets, plywood crank wheel and base, brass crank pin, Ø8 mm polished guide rods.
- Drive the crank with a 12 V DC geared motor (approximately 60 RPM) with PWM speed control for continuous demonstrations.
- Constrain the yoke on twin slide-bearing guide rods so the slot-pin contact is visible and the motion is strictly linear.
- Verify the kinematics experimentally: stroke = 2 × crank radius, cycle time versus the theoretical 1 s at 60 RPM, and SHM velocity behaviour.
- Deliver dimensioned fabrication drawings, a motion-timing chart, report, PPT and viva Q&A.;

05. Proposed Methodology

(1) Kinematic design: with crank radius r and crank angle θ, slider displacement $x = r \cdot \cos(\theta)$, velocity $v = -r\omega \cdot \sin(\theta)$ and acceleration $a = -r\omega^2 \cdot \cos(\theta)$ are computed for the three radius settings at the motor's rated speed; maximum slider velocity at 40 mm radius and 60 RPM is approximately 0.25 m/s. (2) Part design: the yoke block carries a vertical slot sized for the brass pin with a small running clearance; the block is bolted to the slider rod and rides on two Ø8 mm guide rods through slide-bearing blocks. (3) Fabrication: milling/filing the slot, drilling and tapping the pin holes, turning the crank shaft, and assembling the plywood base with fasteners. (4) The 12 V geared motor drives the crank wheel directly, with a PWM controller for speed adjustment. (5) Experimental verification: stroke length is read on the graduated scale at each pin setting, cycle time is timed with a stopwatch, and results are tabulated against theory in the report.

06. System Architecture / Working

The drive chain is motor → crank wheel → crank pin → slotted yoke → slider rod. The motor turns the crank wheel at approximately 60 RPM; the brass crank pin, fixed at the selected radius on the wheel face, orbits with it and engages the vertical slot of the yoke block. The pin's horizontal motion component drives the yoke left and right while its vertical component slides freely along the slot — this is what separates the rotation into its SHM projection. The yoke, bolted to the slider rod and constrained by the twin guide rods, moves only along the slider axis, producing sinusoidal reciprocation: peak velocity at mid-stroke, zero velocity at the two dead centres. The slot-pin interface is deliberately left visible from the side so observers can see exactly where the textbook diagram's 'contact point' really is.

07. Hardware / Software Requirements

- Materials: mild steel flat/bar stock (yoke, brackets), plywood 18 mm (base, crank wheel), brass rod (crank pin), Ø8 mm polished steel rod (guides/slider)
- 12 V DC geared motor, approximately 60 RPM (design target), with PWM speed controller and 12 V supply
- 608-ZZ ball bearings for crank-shaft support; standard M5/M6 fasteners, washers, nuts
- Workshop tools: drill press, taps, files, hacksaw, measuring instruments; welding not required
- Documentation: 2D CAD/drawing tool for fabrication drawings, PDF reader, presentation software

08. Expected Outcomes

A fully assembled motorized Scotch yoke model demonstrating true simple-harmonic reciprocating motion with three selectable stroke lengths (40/60/80 mm, design values), a graduated stroke scale for live measurement, dimensioned fabrication drawings with a fastener/material list, a motion-timing chart (crank angle vs displacement/velocity/acceleration), and a report with SHM derivations, design calculations and experimental observation tables. The student can derive the SHM equations from the mechanism geometry and defend every design choice in the viva.

09. Applications

- Teaching aid for theory-of-machines and kinematics laboratories
- Valve-actuator and small-pump drive demonstrations

- Test rigs requiring sinusoidal reciprocating loading
- Foundation build for comparing Scotch yoke against slider-crank motion

10. Future Scope

- Add an encoder and microcontroller-based stroke counter/RPM display
- Instrument the slider with a load cell to study pin-slot contact forces
- Compare measured motion against a slider-crank model on the same base
- Scale up to a double-acting pump demonstrator driven by the yoke