

**WASHTENAW COMMUNITY COLLEGE
COURSE-SYLLABUS APPROVAL FORM (CSAF)**

For help screens, select a field and press F1

SECTION I COURSE SUBMISSION INFORMATION

1. **Course:** (Enter proposed discipline, number & title here. If changing the number or title of an existing course, give old number or title in box 4 below.)
Discipline/No: ROB 212 **Title:** Robotics II

Division Code: TEC **Department Code:** IND **Requested Start Term:** F98

2. **Type of Approval:** (applies to both new courses and changes)
 Full Approval
 Conditional Approval
 This proposal has received conditional approval previously.
Term Offered: _____

3. **Reason for Submission:** This Course is being submitted for: (check all that apply)
 New Course Approval (Skip the rest of Section I and go directly to Section II.)
 Five-year Syllabus Review No changes to course
 Major Change(s)
 Minor Change(s) (If not due for review, submit sections I, II, and revised parts of Section III.)
 Reactivation of Inactive Course
 Termination (Submit Sections I and II only.)

4. **Change Information:** (Check all that apply. Make proposed changes in Section III, Course Syllabus.)

<p>Minor Changes</p> <input checked="" type="checkbox"/> Course Discipline/Number (was <u>INM 212</u>) <input type="checkbox"/> Course Title (was _____) <input type="checkbox"/> Course Description <input type="checkbox"/> Capacity (capacity was: _____) <input type="checkbox"/> Pre or Corequisites within Department <input type="checkbox"/> Course Objectives (minor changes) <input type="checkbox"/> Distribution of Contact Hours (contact hours were: lect: _____ lab _____ clin _____ exp _____) <input type="checkbox"/> Distance Learning - minor (Attach Preliminary Approval Form for Distance Learning & the Section Handout.) <input type="checkbox"/> Other _____	<p>Major Changes (Major changes will be reviewed by Curriculum Committee.)</p> <input type="checkbox"/> Credit hours (credits were: _____) <input type="checkbox"/> Core Element Approval <input type="checkbox"/> first time <input type="checkbox"/> add additional elements <input type="checkbox"/> Core Element Removal (Elements to be removed _____) <input type="checkbox"/> Grading <input type="checkbox"/> Pre or Corequisites outside Department <input type="checkbox"/> Course Objectives (major changes) <input type="checkbox"/> Total Contact Hours (total contact hours were: _____) <input type="checkbox"/> Honors (Complete Part G of Section III, Honors Addendum.) <input type="checkbox"/> Distance Learning - major (Attach Preliminary Approval Form for Distance Learning & the Student Handout for the Distance Section.) <input type="checkbox"/> Other _____
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5. **Rationale for changes:**
 Students are confused when attempting to register. They are unable to find the courses for 'Robotics' in the time-schedule and bulletin

SECTION II COURSE REVIEW INFORMATION AND SIGNATURES

1. **Department Review** (To be completed by department chair, if recommendation is no, initial and return to preparer with rationale attached.)

Will additional resources be required? yes no (If yes, explain _____)
 Have departments that may be affected by this course been consulted? yes no (Explain _____)
 Does the department support approval of this course? yes no

Print: George Agin Faculty/Preparer Signature: [Signature] Date: 3/5/98
 Print: George Agin Department Chair Signature: [Signature] Date: 3/5/98

2. **Division Review** (To be completed by division dean, if recommendation is no, initial and return with rationale attached.)

If additional resources are needed, have they been secured? yes no No new resources are needed.
 Is this a curricular priority for your division? yes no (Comment _____)
 What is your estimate of projected enrollment? 15

Recommendation Yes No
 Division Dean's Signature: [Signature] Date: 3/10/98

3. **Curriculum Committee Review** (Attach additional comments if necessary.)

Recommendation Yes No
 Curriculum Committee Chair's Signature _____ Date _____

4. **Vice President for Instruction and Student Services Approval** (Attach additional comments if necessary.)

Recommendation Yes No
 Vice President's Signature: [Signature] Date: 3/13/98

Data File: 3-16-98 ACS Code: 12 Catalog File Date: 3-16-98 CTF File Date: _____
 Core Elements Approved: _____ New Syllabus Date: _____

ROBOTICS II
MASTER LESSON PLAN

Im 212

INM 212
ROB

COURSE: CONTINUOUS PATH UNIMATE (2005F)

MATERIALS: Equipment manual, Continuous path supplement, Handouts, chalkboard, overhead projector.

OBJECTIVE: Upon completion of course student will be able to program, repair, troubleshoot, and maintain the UNIMATE Industrial Robot 2005F Series.

INTRODUCTION

A. Procedure:

1. Lecture subject.
2. Demonstrate (Instructor)
3. Exercise: 5 step program (Student)

B. Unimation History:

1. Original patents filed 1952 by George Devco, Chief Engineer for Sperry Rand Corp.
2. Unimation organized in 1962 by Condec and Pullman Corp.
3. First UNIMATES shipped to customers in 1963 (1000 Series).
4. 2000A Series introduced in 1966.
5. 4000A and 2000B Series introduced in 1972.
6. 4000B Series introduced in 1974.
7. 2005F Series (Continuous Path introduced in 1975.
8. 2200B Series (Heavy Duty Wrist) introduced in 1976.
9. PUMA Series introduced in 1979.
10. APPRENTICE Series introduced in 1980.
11. 9000 Series introduced in 1981.

I. UNIMATE DESCRIPTION

A. Description of Motion (Relate to Human Arm):

1. Three major motions (Rotary, Out/In, Down/Up).
2. Two minor motions (Bend, Yaw).
3. Explain Clamp/Weld functions.

B. Describe Drive Components of motions (servo valves, actuators, chains, sprockets, drive shafts, gear box).

II. DESCRIPTION OF TEACH CONTROL

A. Control Buttons:

Explanation and demonstration of all Teach Control buttons.

B. Practical Exercise:

1. Demonstrate Point-To-Point movement.
2. Demonstrate Velocity (Continuous Path) vs. Point-To-Point movement.
3. Each student to use Teach Control.

V. DESCRIPTION OF CONTROL PANEL (at console) (Read Chapters 2 & 3)

A. Describe Switches/Buttons:

Teach a short program and demonstrate functions of switches/buttons on Control Panel.

B. Practical Exercise:

Each student to record a short program and demonstrate an understanding of Control Panel functions.

EXPLANATION OF SYSTEM - BASIC BLOCK DIAGRAMS (classroom)

A. Teach Mode:

1. Teach Control
2. Servo valve
3. Actuator
4. Encoder

B. Repeat Mode:

1. Memory
2. Encoder
3. Comparator
4. Servo valve
5. Actuator

1. EXPLANATION OF ACCURACIES 1, 2, AND 3 (PTP only)

A. Definition of Accuracy.

B. Explanation of How Accuracy is Accomplished:

1. Encoder.
2. Analogy: tape measure vs. encoder.

C. Explain Why Other Than Fine Accuracy is Used:

1. Save time
2. Save wear on mechanical drive components.

D. Explain Time/Velocity Relationship:

E. Explain Path Arm Will Travel Using Different Accuracies:

1. Arm not reaching Taught points in space.
2. Arm travels shorter distance.
3. Less time in slower speeds.

F. Explain How Accuracy is Taught:

1. Accuracy Selector.
2. Adjustment of ACC. 2 and ACC. 3 potentiometers.

G. Practical Exercise:

Draw "the" eight-step program on chalkboard and explain procedure for teaching.

1. Teaching the different accuracies.
2. Teaching steps out of sequence.
3. Adjustment of accuracy potentiometers.
4. Emphasis on path change when potentiometer settings are changed.

H. Summarize Accuracies 1, 2, and 3.

II. DESCRIPTION OF TEACH PANEL (classroom)

A. Explanation of OX/WX Interlocks:

1. Relays to send signals to, or receive from, external equipment.
2. Causes external equipment to operate.
3. Causes UNIMATE to stop until external equipment cycle is completed.

B. Description of Operate External (OX):

1. An electrical signal sent from the UNIMATE to enable/disable external equipment.
 2. Utilization of external power source through isolated contacts of relay. Rated at 120VAC, 3A.
 3. OX relay activated at beginning of step on which it is taught.
 4. Signal lasts duration of step.
 5. Procedures for teaching an OX function.
- C. Description of Wait External (WX):
1. The closing of a normally open limit switch allows the UNIMATE to proceed to the next position.
 2. External voltage NOT to be applied to WX circuits.
 3. Example of limit switch on chalkboard.
 - a. Open when arriving at position (stop).
 - b. Closed when arriving at position (continue).
 - c. Closed before reaching position but open when arriving (stop).
- D. Description of WX Override:
1. Will override all WX signals.
 2. Will override Time Delay signals.
- E. Description of Time Delay (not used in Velocity mode):
1. Adjustable 0-12 second time delay.
 2. Cannot be programmed on consecutive steps.
 3. Time delay starts at beginning of step.
 4. The length of time selected on TD potentiometer will be the same for all TD steps in program.
 5. Explanation of "cascading" as it relates to the TD function on UNIMATE robots.
- F. Summarize Operate External, Wait External, and Time Delay.

III. INTERLOCK JUNCTION BOX - CUSTOMER ACCESS PANEL

Location and Description

X. PROGRAM SELECTOR SWITCH

- A. Memory Description and Location:
1. Plated Wire vs. CMOS
 2. Maintenance procedures for CMOS memory.
 3. Relationship of Program Selector Switch and memory.
- B. Explanation of RANDOM PROGRAM SELECTION (RPS):
1. Typical interfacing procedures.
 2. Programming procedures for RPS function.

SAFETY SUMMARY

Review Pages ix - xi in Equipment Manual.

I. SAFETY CONSIDERATIONS

- A. Limiting UNIMATE Movement:
1. Mechanical stops.
 - a. External to UNIMATE - "I" beam.
 - b. Internal - actuator stroke limiters.
 2. Electrical Stops.

Interfacing with Interlock Junction Box.

- B. Restricting Movement of Personnel/Equipment into Reach of the UNIMATE:
1. Barrier fences with interlock circuits.
 2. Rope off area.
 3. Mark floor area UNIMATE can reach.
 4. Post warning signs.

II. INSTALLATION OF THE UNIMATE

- A. Location:
1. On a solid, preferably concrete, floor.
 2. Be able to reach all program areas.
 3. Base level within 5 degrees.
 4. Boom as horizontal as possible for majority of steps.
 5. Centerline of boom as perpendicular as possible to the major work area.
- B. Mounting:
1. Firmly fastened (refer to UNIMATE Equipment Manual)
 2. Accuracy is relative to UNIMATE base.
- C. Service Area:
- Three feet on all sides for servicing and cooling.

III. HYDROMECHANICAL

- A. Motor:
1. Electric with thru shaft
 2. 10 hp
- B. Pump:
1. Vickers vane pump
 2. 17 gpm
- C. Reservoir:
1. Vented
 2. 22 gal. capacity
- D. Oil, Hydraulic:
1. Non-detergent, petroleum base
 2. Filtered to 3 microns, 1.5 absolute
 3. Fire resistive fluid available (Pycraul or Quaker)
- E. Filters:
1. Full flow
 2. 3 micron outer paper; 25 micron inner metal
- F. Valve, Unloading:
1. Maintains system pressure
 2. Factory set at 750 - 950 psi
- G. Valve, Check:
- Checks reverse flow when unloading valve unloads.
- H. Accumulator:
- Bladder type; 2 1/2 gal charged to 525 psi N₂
- I. Gauge, Pressure:
- Liquid dampened
- J. Valve, Dump:
- Allows return of oil under pressure to reservoir
- K. Valve, Servo:
1. DC activated

2. 24 gpm
3. One per motion
- L. Valves, Relief:
 1. Rotary motion - 1100 psi.
 2. Bend/Yaw motion - 480 psi.
 3. Return repair
- M. Feedthru System:
 1. Description
 - a. Oil under pressure is fed to the inner cavity of a concentric assembly.
 - b. Oil under return pressure fed to outer cavity.
 - c. Feedthru standside is stationary.
 - d. Dynamic part of Feedthru system is Feedthru Manifold attached to rotating trunk.
 - e. Feedthru Manifold contains 3 chevron seals.
 - f. Note direction of seals for installation.
 2. Troubleshooting
 - a. Take UNIMATE "pulse" and enter in logbook.
 - b. Listen for bypass of oil from pressure side to return side.
 - c. Explain seal replacement procedure.
- N. Fixed Base:
 1. Describe function of following components:
 - a. Backlash control piston
 - b. Metered oil input
 - c. Return oil output
 2. Troubleshooting fixed-base rotating trunk area.
 - a. Clogged return line
 - b. Defective rotary actuator seal(s)
 - c. Backlash control piston seal

IV. SERVO VALVE

- A. Description and Function - General:

An infinite position valve that directs the flow of hydraulic oil to one side or the other of an actuator. The volume of this flow is directly proportional to the distance the motion has to travel to the taught point.
- B. Description and Function- First Stage Servo Valve:
 1. 4 ports: pressure, return, control ports(2)
 2. Trace pressure flow to filter cavity.
 3. Trace pressure flow through restrictor inlets to nozzles.
 4. Two coils in torque motor.
 5. Current supplied to one side deflects armature and causes flapper to restrict one nozzle.
 6. Pressure increases and is transferred to rear of spool. Spool then shifts and carries feedback wire with it.
 7. Torque supplied by the spool through the feedback wire centers the flapper. When torque on feedback wire equals torque on coil, spool shifts no further.
 8. The larger the input signal to the torque motor the further the spool shifts; the further the spool shifts the larger the opening to control ports thus creating an increase in volume flow

which leads to faster motion.

C. Description of Dynamic Pressure Feedback (DPF):

1. Pressure transducers added to Rotary and Down/Up motions.
2. When a servo valve starts to close and pressure peaks, an electric signal is produced.
3. Signal is fed back to open the servo valve and relieve pressure.
4. Reduces spring action (bounce).
5. Only active in Repeat mode on Velocity steps.

D. Nulling Servo Valves:

1. Purpose:
To achieve equal speed in both directions for each motion.
2. Considerations before nulling:
 - a. Is present state of servo valve affecting execution of program?
 - b. Is oil at operating temperature?
 - c. Is a spare servo valve on hand?
3. Procedures:
 - a. Initial adjustment by eye so that the motion appears to be traveling at near equal speed in both directions.
 - b. Using UNIMATE Tester, fine motion in creep speed should be equal.
plus or minus 1.
 - c. Readjust if necessary.

E. Practical Exercise:

Students, in groups of two, will perform nulling procedures on UNIMATE.

F. Troubleshooting:

1. Drifting: motion(s) moves at a near constant rate.
 - a. Valve out of null
 - b. Sticking servo valve
 - c. Faulty actuator
 - d. Plugged nozzle
2. Motion stops short of taught point:
 - a. Contaminated servo valve
 - b. Tight actuator seal
 - c. Creep speed set too low
 - d. Mechanical binding

G. MEMORY STEP DATA FORMAT AND TESTER ORIENTATION:

A. Description of Table:

The table shows the location of all information that can be taught into the memory. It consists of eight groups (words) with each group capable of sixteen bits (1's or 0's). Only 15 bits of each group are used for encoder position codes or auxiliary information. The sixteenth bit is used for odd parity.

B. Odd Parity:

1. While writing into the memory, odd parity generation on the 0181 boards is accomplished as follows:
The fifteen bits of information per group is sent to the 0181 boards. The parity generators on these boards look at the incoming bits and determine if the number of 1's in each group is

odd or even. If the total number of 1's is even, the parity generator will generate the sixteenth bit. Thus each group will have an odd number of bits recorded into memory.

2. Odd parity while reading the memory.

During Repeat, parity checking is done to ensure that each group is sending an odd number of bits of information from memory. If an even number is detected the UNIMATE is placed into an electrically inhibited state.

C. Tester and Test Panel:

1. Allows adjustment and troubleshooting procedures to be accomplished.
2. Gives the ability to read what is written into the memory.
3. Group mode allows the changing of information in one group without changing the other seven.
4. Worthwhile aid when programs have been changed without noting changes on program sheet.

1. ENCODER

A. Description:

1. Relative position indicator that identifies the location of a motion in space.
2. Mechanically driven by motion drive system.
3. Binary explanation.
4. Photoelectric, 15 bit capacity
5. Resolution of each encoder to within .010 inches
6. Repeatability of the UNIMATE to within .050 inches

B. Description of Model Encoder Components (3 track):

1. Clear disc
2. Three segmented concentric tracks, 50% clear, 50% masked
3. Edge view showing segmented disc, drilled cover, drilled mask, light source, parabolic mirror, photoelectric cells

C. Encoder Zeroing - Purpose:

1. To have a known starting place and a specific code for it.
2. Allows replacement or rezeroing of encoders without having to reprogram.

D. Considerations Before Zeroing:

1. If programming had been accomplished while one or more encoders were not correctly zeroed, rezeroing will cause the motion(s) to be displaced. If the displacement is not large only the accuracy steps will need to be reprogrammed.
2. If encoders are rezeroed new tapes must be made.

E. Practical Exercise:

Students in groups of two, will perform encoder zeroing procedures as explained.

F. Troubleshooting:

1. Motion moves to incorrect location; codes on tester match.
Encoder zeroed incorrectly
2. Motion moves to taught location in wrong direction.
Encoder zeroed incorrectly
3. Motion goes to taught location and shakes.
More than one bit transitioning at a time

4. UNIMATE will not move in repeat; "W" board IT2 LED and Encode Monitor LED on.
Encoder lamp defective (out, dim, dark spot).

II. BLOCK DIAGRAMS

- A. The purpose of the Teach/Repeat block diagrams is to act as an aid while troubleshooting the UNIMATE. As you look at any block on the diagrams you can clearly see what signals are going into and out of that block. A signal can be traced from its source to its destination and any component that interrupts this signal can easily be identified and replaced. Unimate's maintenance philosophy is to isolate the problem to an easily replaceable component thus minimizing machine downtime.
- B. Tracing a Motion Signal in Teach Mode:
 1. Pressing a plus or minus button on the Teach Control will send that signal to the Servo Direction board.
 2. This signal is latched onto the Servo Direction board and sent to the Servo Power Amplifier board.
 3. The signal is modified here and sent to either the plus or minus coil of the servo valve.
 4. The spool of the servo valve shifts, directing oil under pressure to one end of an actuator.
- C. Teaching Information into the Memory:
 1. Information comes from 3 areas when the Record button is depressed:
 - a. Encoders
 - b. Teach Panel
 - c. Teach Control
 2. Description of 1 - 8 Group Scanner.
 3. Purpose of the Input boards (parity).
 4. Sequence of Events when Record Button is Depressed.
 - a. Signal sent to Write/Read board to activate system clock which drives the 1 - 8 Group Scanner on the Address board.
 - b. Group Scanner synchronizes the addressing of the 8 groups of input information and the gating of this information into memory.
 - c. After scanning the 8th group, the system clock and Group Scanner is deactivated and the next
- D. Tracing a Signal in Repeat Mode (PTP):
 1. System clock on Write/Read board activated to drive 1 - 8 Group Scanner on Address board.
 2. Group Scanner synchronizes the output information from memory which is sent to the Comparator board. The Comparator also receives the positional codes from the encoders and compares each. The differencers will manifest themselves as a proportional DC voltage sent to the Servo Power Amplifier board and as a plus or minus signal to the Servo Direction board.
 3. The Servo Direction board then sends the plus or

minus directional signal to the Servo Power Amplifier board where it is modified.

4. This directional signal is then sent to the servo valve, shifting its spool a distance directly proportional to the DC voltage applied.
5. The flow of oil to the actuator is also directly proportional, resulting in a proportional velocity for the motion.
6. Explanation of all signals shown in Repeat block diagram.

III. TROUBLESHOOTING LIGHTS

A. Purpose:

To facilitate troubleshooting the UNIMATE in an electrically inhibited state during Repeat mode.

B. Components:

1. Write/Read board
2. Total Coincidence board
3. True Total Coincidence board
4. Interpolation Timer board

A dimly lit LED during ATP portions of the program has no significance.

eff 9/01

Course Descriptions

Division: Technology
Industrial Technology Department

ROB 174: ROB Co-op Education I 1-3 Credit(s)

Prereqs: Consent required
Coreqs: None
0 lecture, 0 lab, 0 clinical, 0 other, 0 total contact hours
Fulfills Core Elements: None

Last Updated: Fall 1999
Current Syllabus Date: Fall 1993

Course Description:

In this course, students gain skills from a new experience in an approved, compensated industry-related position. Together with the instructor and employer, students set up work assignments and learning objectives to connect classroom learning with career-related work experience. This is the first of two possible co-op experiences. Instructor consent is required to register for this course.

This course used to be: INM 174

ROB 212: Robotics II 4 Credit(s)

Prereqs: ~~ROB 121~~ ROB 121 OR CONSENT
Coreqs: None
30 lecture, 60 lab, 0 clinical, 0 other, 90 total contact hours
Fulfills Core Elements: 7 9 11 18 19

Last Updated: Fall 1999
Current Syllabus Date: Winter 2001

Course Description:

This class concentrates on programming techniques. Students learn to program different types of robots incorporating inputs and outputs into their programs. The course is based on a series of student projects that, step by step, introduce each new command or concept. Students spend most of the class time in the lab and are expected to spend extra hours during scheduled open labs.

Students who have experience equivalent to ROB 121 may contact the instructor for permission to waive the prerequisites.

This course used to be: INM 212

ROB 223: Robotics III 4 Credit(s)

Prereqs: ROB 212
Coreqs: None
30 lecture, 60 lab, 0 clinical, 0 other, 90 total contact hours
Fulfills Core Elements: 7 9 11 18

Last Updated: Fall 1999
Current Syllabus Date: Winter 2001

Course Description:

Students learn to work with peripheral devices in various robotic workcells. Experiments include part recognition, counting, distance measuring, sorting, and palletizing. Programmable controllers are interfaced with robots in an integrated manufacturing cell. The students are introduced to robotic simulation, vision systems, and bar coding.

This course used to be: INM 223

ROB 224: Robotics IV 4 Credit(s)

Prereqs: ROB 223
Coreqs: None
30 lecture, 60 lab, 0 clinical, 0 other, 90 total contact hours
Fulfills Core Elements: 7 8 9 11 12 18 19

Last Updated: Fall 1999
Current Syllabus Date: Winter 1996

Course Description:

This course involved advanced programming of robots and programmable controllers in an integrated workcell. Problems related to maintenance and trouble-shooting constitute a major segment of the course. A group project involving the design and construction of a workcell that simulates some industrial process is an enjoyable conclusion to this program.

This course used to be: INM 224

JZU
4/17/01

FOR INDUSTRIAL ROBOTS.