Name of the Examinations: M.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING FIRST YEAR FIRST SEMESTER - 2018

Subject : PROGRAMMING METHODOLOGY **Time :** 3 Hours **Full Marks :** 100

Instructions : Answer any ***five*** questions ; All questions carry equal marks

1 Explain the operational semantics of a repetitive construct? Design a program that divides a nonnegative integer X by a positive integer Y by using repeated subtractions. Show that the program you design would terminate and will produce the required result. You may choose suitable post condition, integer function and invariant.

5+7+8

2 Define Weakest precondition. State and prove all the properties of wp(S,R). **Hence** prove that wp(S, 'non A') or wp(S, 'B') $\Rightarrow$ wp(S, 'A$\Rightarrow$B')
Apply this formula to prove that wp('X:=a' , R) = true when R = (a>5 $\Rightarrow$ x >5)

3+8+4+5

3(a) State the expression for wp(DO,R). In connection with wp(DO,R) explain the meaning of $H_K(R)$ and justify the form
$H_K(R) = wp(IF, H_{K-1}(R))$ or $H_0(R)$

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3(b) Let a guarded command set with its derived alternative construct IF and a predicate P be such that P and BB $\Rightarrow$ wp(IF,P) holds for all states.
Show that for corresponding repetitive construct DO we get
P and wp(DO, T) $\Rightarrow$ wp(DO, P and non BB) holds for all states.

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4 Design a program that finds the **GCD** of two positive integers. Show that your program terminates and produces correct result. You may assume the required invariant and the integer function.

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5(a) Describe the case construct used for the semantic specification of non-basic T functions. Show how the semantics of an IF construct may be described by using case statements

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5(b) Assuming the case free axiom for operator + on natural number and using generator induction prove that

(i) $\forall x , y : Nat : x + (y + z) = (x + y) + z$

(ii) $\forall x , y : Nat : x + y = y + x$

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6(a) Consider an abstract data type seqT as a sequence of type T. The generator basis and the function profiles are defined as follows.

type seqT
func ε: → seqT (empty sequence)
func ^ ⊢ ^: seqT × T → seqT (append right)
func ^ ⊣ ^ : T × seqT → seqT (append left)
func ^ ⊢⊣ ^ : seqT × seqT → seqT (concatenate)
func rev ^ : seqT → seqT (reverse)
func # ^ : seqT → Nat (length)
genbas (ε, ⊢)

Give semantic specification of all the non-basic functions using case construct.

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6(b) Assuming the semantic definitions described in part (a) and applying the method of induction prove that

$\forall q,r:\ seqT \bullet \#(q \vdash\!\dashv r) = \#q + \#r$

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7(a) State the expression for wp('x:=e' , R)
Hence find
(i) wp('t := x ; x : = y; y := t' , $x = A \wedge y = B$)
(ii) wp('t := x ; y := t ; x := y' , $x = A \wedge y = B$)
(iii) wp('x := x + y ; y := y – x ; x : = x – y' , $x = A \wedge y = B$)

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7(b) Let $Q \Rightarrow BB$
and $(\forall j : 1 \le j \le n : (Q \wedge B_j) \Rightarrow wp(SL_j, R))$ holds for all states
then prove that $Q \Rightarrow wp(IF, R)$ for all states

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8(a) What are the different parameter passing mechanisms in connection with a procedure call? Illustrate your answer with examples.

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8(b) Let a procedure be defined as

Procedure Proc(value $\bar{x}$; value result $\bar{y}$; result $\bar{z}$)
{P} < body > {Q}
and let a procedure call be represented by $Proc(\bar{a}, \bar{b}, \bar{c})$ such that the corresponding post condition is R, then prove that the required weakest precondition PR for this call is

$$\{PR : P^{\bar{x},\bar{y}}_{\bar{a},\bar{b}} \wedge (\forall \bar{u}, \bar{v} : Q^{\bar{y},\bar{z}}_{\bar{u},\bar{v}} \Rightarrow R^{\bar{b},\bar{c}}_{\bar{u},\bar{v}}\}$$

Also show how the above result may be simplified.

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